The Electrical Industry's Weekly Magazine

August 10, 1959

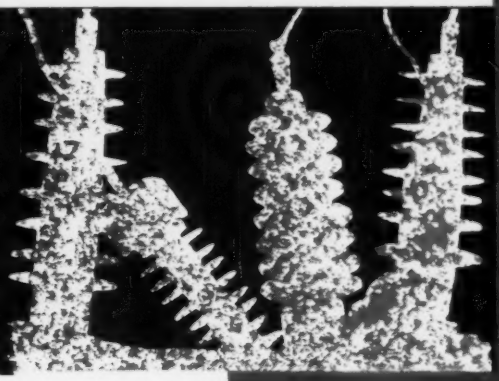
# Electrical World

Price 50 Cents

A McGraw-Hill Publication

A SPECIAL REPORT

## INDUSTRIAL ELECTRICAL SYSTEMS



Survey of Industrial Distribution System Design Practice..... p 65

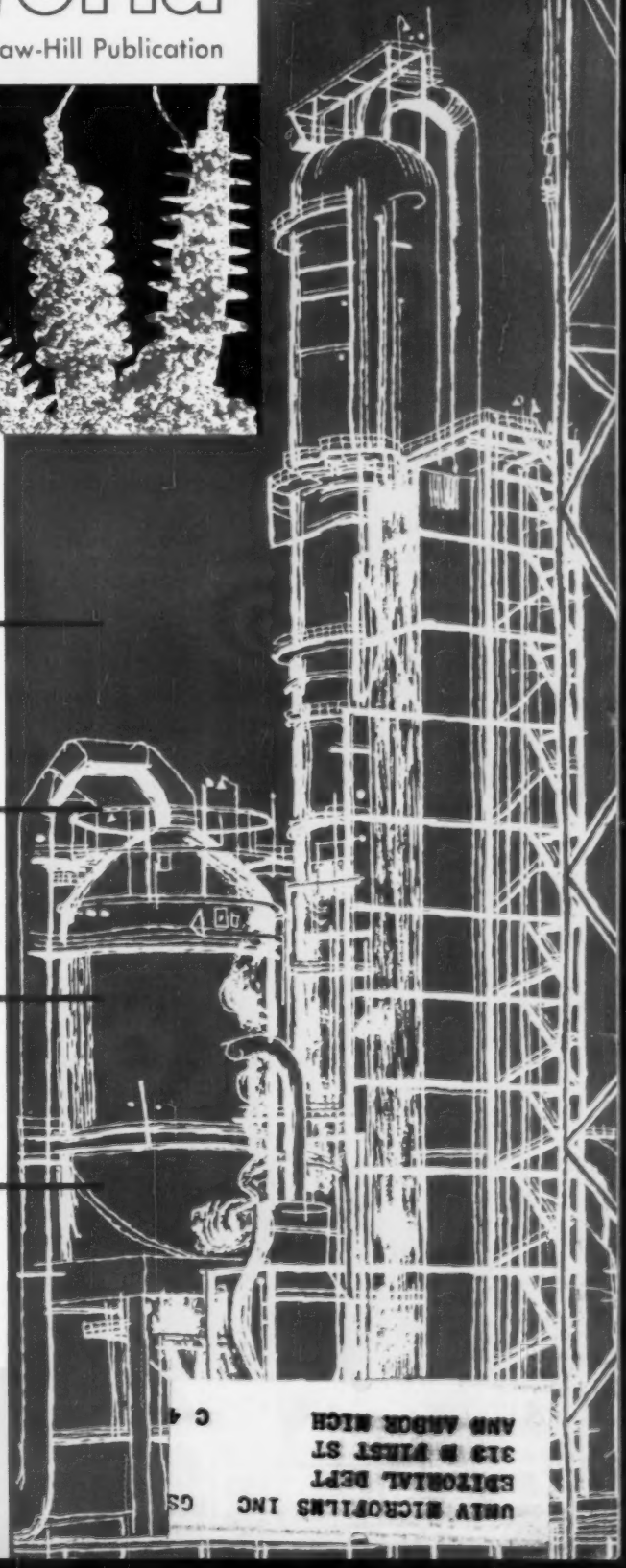
More for Your Transformer Dollar? Take Another Look at Real Costs... p 70

4 Kv or 13 Kv . . . Which Voltage is Best for 10 to 20-Mva Systems..... p 76

19 Ways to Get More Protection From Your System Relay Plan..... p 84

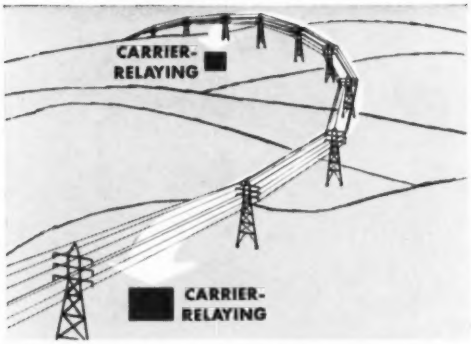
Simple Method Speeds Industrial System Short Circuit Calculations..... p 92

How Do You Rate Your Managers? . . . p 105



UNIV MICROFILMS INC
EDITORIAL DEPT
313 N FIRST ST
ANN ARBOR MICH

NEW G-E STATIC RELAY and the carrier complete staged fault test on Muskingum-Philo 138-Kv line of Ohio Power Co. Checking new relay are Mr. Arthur Hauspurg, Relay Section Head, American Electric Power Service Corp.; and Mr. R. H. Macpherson, Manager—Relay Engineering for General Electric.




TRANSISTOR CARRIER CURRENT CHANNEL, together with General Electric's new Static Phase-comparison Relay, provides co-ordinated transmission line protection.

W. E. HUNT, MANAGER—Relay Sales, displays module construction of new static phase-comparison relay.

# General Electric Opens a New Era in Protective Relaying

*. . . with first static phase-comparison relay*

The perfection of reliable static components makes possible practically maintenance-free relays . . . desired by utility men for years. In addition, improved forms of relays using static components will open new fields of application never economically possible before. Static protective relays can now be created that will provide the functions and the characteristics required by modern power systems—higher speed, less maintenance, increased sensitivity, lower burdens.

A line of static protective relays is now on the drawing board for protection of the complete electric utility system . . . transmission lines, transformers, generators and buses.

**STATIC PHASE-COMPARISON RELAY** is the first in the General Electric line of new static relays. It compares the phase position of currents at the line terminals to provide simultaneous, high-speed tripping of a faulted transmission line. Transistor measuring elements provide higher speed, improved stability of characteristics, and reduction in maintenance costs.

**G-E TRANSISTOR CARRIER CURRENT EQUIPMENT** provides the communication tie for co-ordinated line protection. Fully transistorized transmitters and receivers offer high-speed channels . . . conservation of frequency spectrum . . . and full 10-watt power output.

This joint product development helps assure electric utilities of improved system protection now . . . and economical system expansion when load growth demands it. 301-406

**MORE POWER TO AMERICA**

**GENERAL ELECTRIC**

# Electrical World

Vol. 152, No. 6 AUGUST 10, 1959

Published for 85 years for those engaged in the business of generating, transmitting, distributing, or applying electric power

## In This Week's Issue

p 48

CURRENT EVENTS

### Detroit Edison Trims Expenses

When industrial loads took a turndown, the utility management instituted effective cost control program.....p 42

MANAGEMENT NEWSLETTER

### How Do You Rate Your Managers?

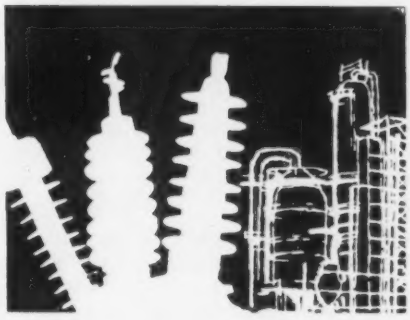
Fixed standards mean fairer ratings, also enables manager to know what is expected of him.....p 105

MEETING REPORT

### Compensation Law Change Discussed

Speaker tells EEI safety group AFL-CIO wants A-plant protection federalized, limit on third-party injury suits.....p 48

## Special Report



p 57

### Industrial Electrical Systems

First survey of industrial electrical design highlights present practices and trends, shows where real design responsibility rests. Series of articles on present day design round out report

**Survey of Industrial System Design Practice**.....p 65

**More For Your Transformer Dollar? Look at Real Costs**..p 70

**4 or 13 Kv . . . Which is Best for 10- — 20 Mva Systems**.p 76

**Reliable 13-Kv Radial Powers Large Compressor Drives**..p 82

**19 Ways to Get More from System Relay Plan**.....p 84

**Simple Method Speeds Short Circuit Calculations**.....p 92

## Departments

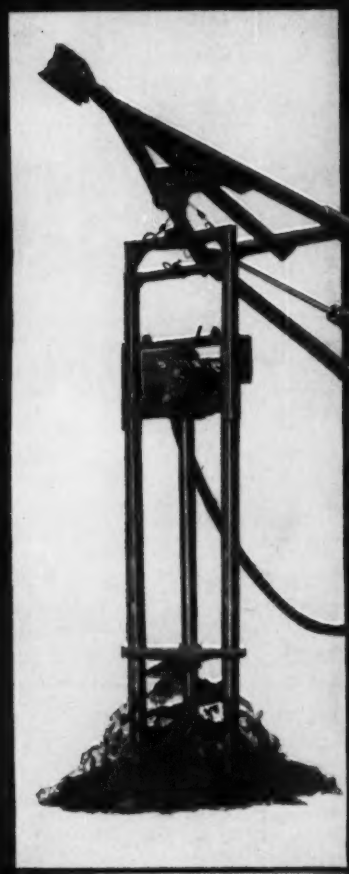
Editorials ..... 41
• Electrical Week ..... 13
Executive Reader ..... 16
In the Industry ..... 5
• Management Newsletter ...105
Manufacturers News ..... 56
New Equipment ..... 59
News About People .....114
Public Power and Politics... 14
• Procurement & Products ... 54
Selling .....111
Readers Service ..... 64
Readers Forum .....126
INDEX TO ADVERTISERS...126

Another reason why
UTILITIES EXPECT MORE FROM

POWERS American

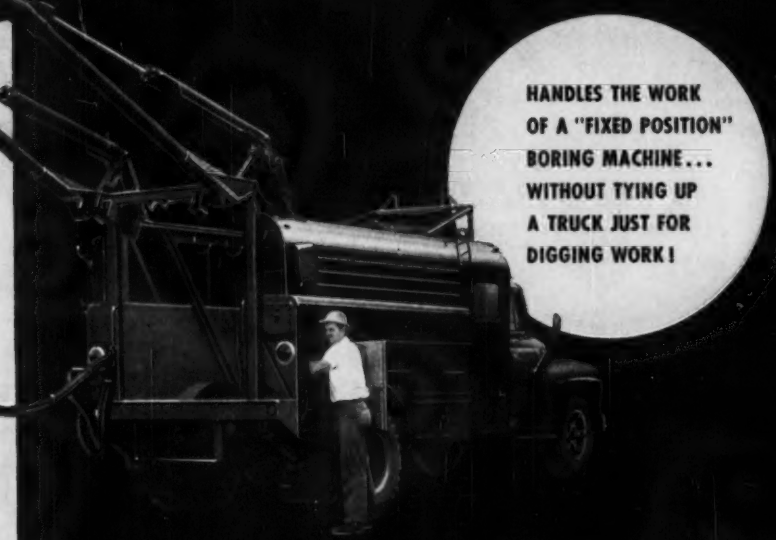
# ALL-NEW
## Series EM-2
# "Earth-Master"
### HYDRAULIC HOLE DIGGER

## THE ONLY PORTABLE DIGGER THAT DOES THE COMPLETE JOB



SERIES EM-1 . . . a smaller version of the EM-2 . . . digs holes to 9'4" deep, from 9" to 20" in diameter.

SERIES DF-1 . . . has auger with Pengo head —in size for digging holes from 9" to 20" in diameter, up to 10' deep.




Here at last . . . a portable digger that digs holes from 9" to 30" in diameter—up to 10'6" deep, vertically or at various angles.

The EM-2, powered by a hydraulic pump utilizing the full torque of the truck engine, is designed for use with a "live boom" derrick such as the Series PM-2 "Pole-Master" Hydraulic Derrick shown in photos.

The unique digging head, providing low speed for digging and high speed for "spin off," is powered by a reversible hydraulic motor; also fed and raised by hydraulic power. It is rigidly guided at all times to assure straight, clean holes consistently—whether the soil is hard or soft, wet or dry.

When not in use the digger does not interfere with operation of the derrick. It can be stowed in special brackets on the derrick or can be easily removed for use on another vehicle.

Why not take a minute right now to send for complete details?

Save time and money . . . let our sales and engineering staff analyze all your truck body and equipment needs

## McCABE-POWERS BODY COMPANY

5900 NORTH BROADWAY · ST. LOUIS 15, MISSOURI

625 CEDAR STREET
BERKELEY 10, CALIF.

5525 S. E. 28TH AVE.
PORTLAND 2, OREGON

# In the Industry

## Output Figures Are Pleasant Reading

For light, pleasant, summer reading, we know of no better material than the weekly output chart and figures (page 13).

During the first seven months of this year, the weekly figures have shown an average gain of 10.8% above the same weeks last year. This is not quite enough to overcome last year's retarded growth rate, but is considerably ahead of our forecast for the year of 9.4% (EW, Sept. 22, 1958, p 101).

While a small part of the high growth rate for the past few months may be attributed to a buildup in steel inventories, the major portion can be traced directly to across-the-board gains in every phase of economic activity. This is most encouraging as it indicates that nothing except a prolonged steel strike (more than eight weeks) will have much effect on load growth in the third and fourth quarters of this year.

However, don't be disappointed if the weekly output increases in the last half run below the astonishing 15% and 17% gains racked up in the weeks before the steel strike. Less spectacular gains would not necessarily indicate a slowdown in our economic growth rate, but rather would reflect the economic pickup in the last half of 1958.


## Electrical World Staff

**Warren W Shew** Publisher

**Charles F Hochgesang** Editor
**Daniel T Braymer** Senior Editor

***Engineering***
**Leonard M Olmsted** Managing Technical Editor
**Howard S Knowlton** New England Editor, Boston
**Edward Allen** Midwestern Editor, Chicago
**Francis J Kovalcik** Methods Editor
**Paul H Leech** Western Editor, San Francisco
**George Swift** Associate Editor
**Kenneth N McLean** Northeastern and Industrial Editor
**Leon A Allen, Jr** Middle Eastern Editor
**William R Shook** Southeastern Editor
**Archer E Knowlton** Consulting Editor

***News***
**Herbert R Frankel** Managing News Editor
**Thomas R Jordan** Assistant Managing News Editor
**Theodore Fuller** News Editor
**Michael G Duerr** Assistant News Editor
**John D Damon** Commercial Editor
**George B Bryant, Jr** Manager, Washington Bureau

***Special Services***
**Arthur J Stegeman** Manager, Market Research
**Dexter M Keezer** Director, Economics Department

***Production***
**Jesse A Mock** Manager of Production
**Frank C Stockman** Art Director
**H Tomlinson Howland, Jr** Associate Art Director
**Paul F Roman** Associate Editor
**Elizabeth R Parker** Assistant Editor
**Steven Ludwig** Assistant Production Editor

***Advertising***
**District Managers:** W R Klein, L R Lawrence, D J Roberts, New York; L R Lawrence, Boston; F P Coyle, Philadelphia; M S Kearney, E F Coffey, Jr, Cleveland; E F Coffey, Jr, Detroit; M S Kearney, Pittsburgh; W H Meneilley and J T Schaefer, Chicago; J T Schaefer, St. Louis; Russell Antles, Los Angeles; R C Alcorn and T H Carmody, San Francisco; Robert H Powell, Atlanta; F E Holland, Dallas; John Patten, Denver.
**Otto A Drechsel** Business Manager
**John F Dugan** Assistant Business Manager
**Donald K Ellis** Promotion Manager

**E Bryson Sessions** Circulation and Sales Service Manager



**ELECTRICAL WORLD**
Vol. 152, No. 6, Aug. 10, 1959

Published weekly by McGraw-Hill Publishing Co., Inc., James H. McGraw (1860-1948), Founder. Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Printed at 99-129 North Broadway, Albany 1, N. Y. See panel at right for information regarding subscriptions or change of address.

Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice-President; L. Keith Goodrich, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, President, Publications Division; Shelton Fisher Senior Vice-President; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.

Subscriptions are solicited from executive, supervisory, and engineering personnel in electric utilities, manufacturing companies, and related fields; and from consulting engineers and electrical engineers in industry. Position and company connection must be indicated on subscription orders. Send to address shown in box at right.

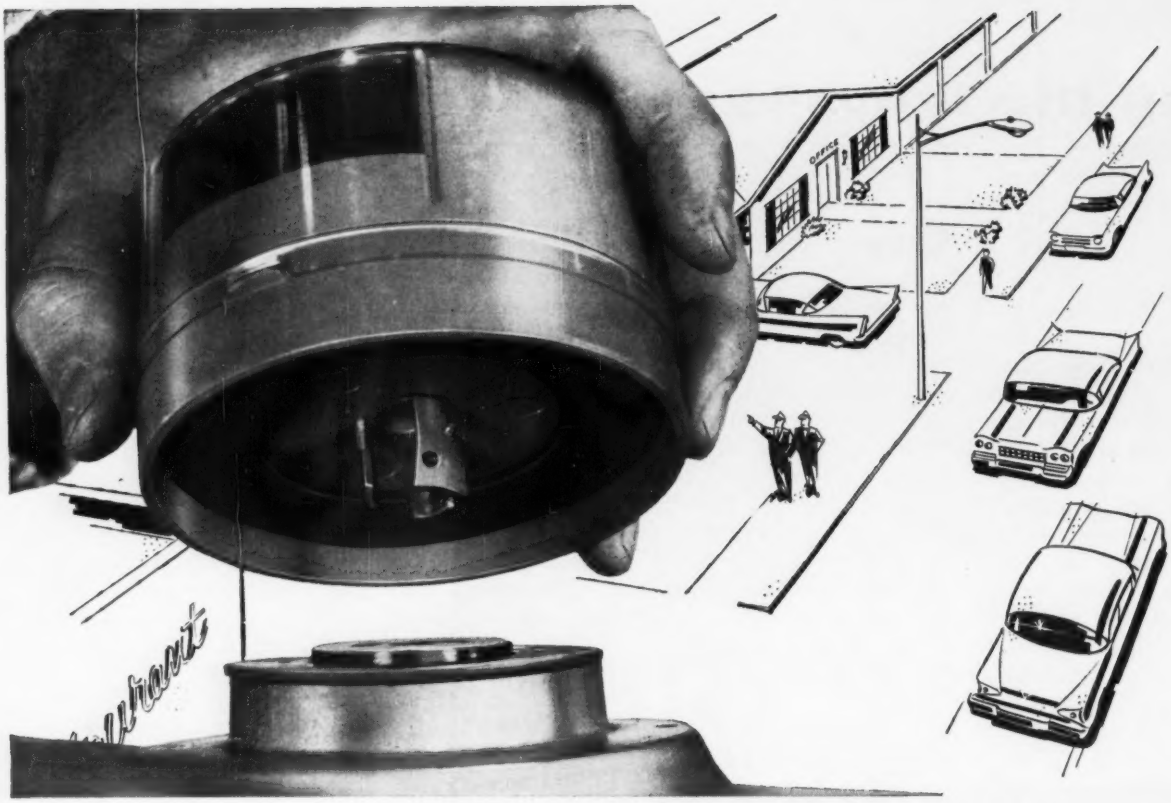
United States and Canada subscription rate for individuals in the field of the publication $6.00 per year; single copies 50 cents. Other Western Hemisphere and the Philippines $20.00 payable in advance and other countries $30.00 payable in advance.

Second-class postage paid at Albany, N. Y. Title registered in U. S. Patent Office.


Copyright 1959 McGraw-Hill Publishing Company, Inc. All rights reserved. Permission required to reproduce any of contents. Printed in U.S.A.


SUBSCRIPTION AND ADDRESS CHANGES: Send subscription correspondence and change of address to Fulfillment Manager, ELECTRICAL WORLD, 330 West 42nd Street, New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Please allow one month for change to become effective.

Postmaster . . . Please send form 3579 to Electrical World, 330 W. 42nd St., New York 36, N. Y.



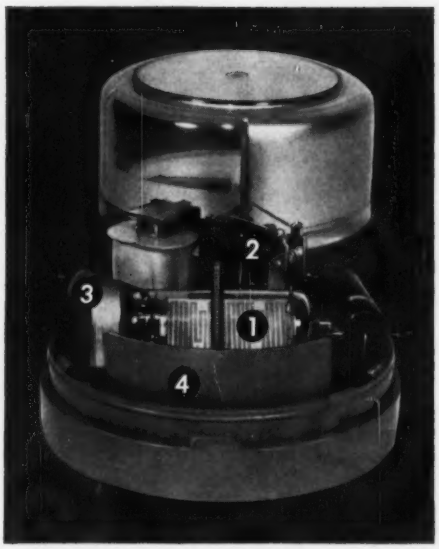
# Reliable—after years of tests

## New G-E cadmium-sulphide control installs in seconds . . . lasts for years

Now, from General Electric comes the industry's newest, most dependable cadmium-sulphide photoelectric control. Years have been spent in the research, design, and testing of this new street lighting control to produce the most efficient, most reliable cadmium-sulphide control available. Now, after exhaustive testing, the reliability problem has been solved with a custom-built General Electric cadmium-sulphide cell. Shock, surge, humidity, vibration, load, temperature—these were among the tests conducted —but none was found to alter the dependable performance of the new G-E control.

Addition of the new cadmium-sulphide cell is but part of the story. General Electric has developed a new, simplified circuit with specially-engineered long-life components . . . designed and built to work together and to reduce your control costs.

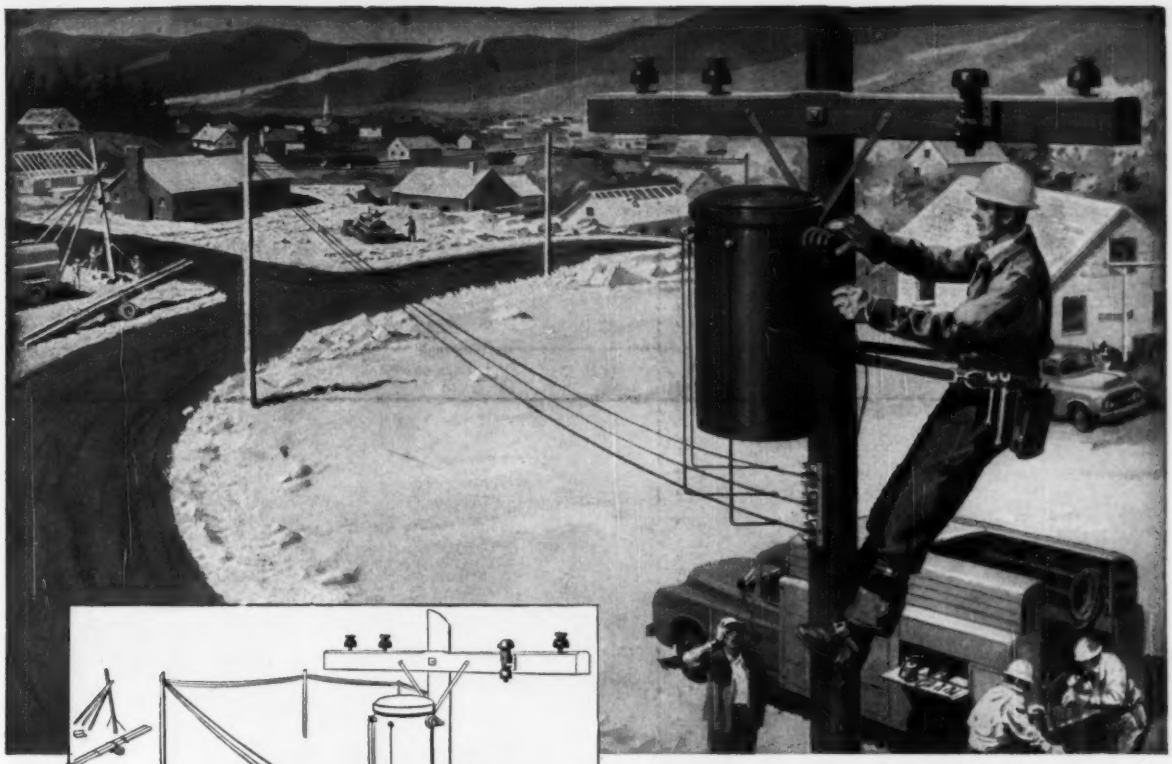
Get the full details from your General Electric Apparatus Sales Engineer or Agent, or write Section 450-25, General Electric Company, Schenectady, New York.

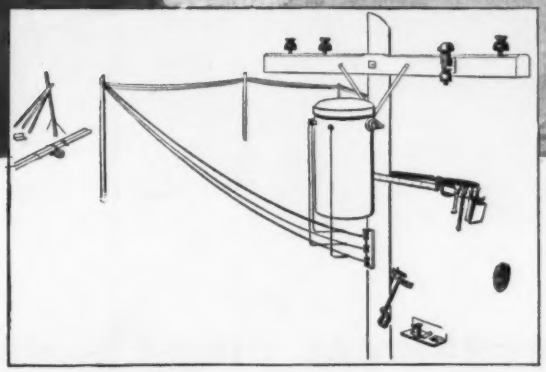



**ADVANCED DESIGN FEATURES** give: (1) dependability from new G-E hermetically sealed cadmium-sulphide cell; (2) long life from specially-engineered components; (3) built-in protection from voltage surges; (4) power savings through accurate external adjustment. NO VACUUM TUBES OR RECTIFIERS.

*Progress Is Our Most Important Product*

GENERAL ELECTRIC





Call your nearest Graybar office for these three helps on pole-line construction:

1. Fast, accurate catalog information and quotation service on over 100,000 electrical items.
2. Stocks of tools and utility standard items for scheduled delivery including pre-fabricated transmission structure assemblies.
3. Assistance in planning through Graybar Outside Construction Specialists.

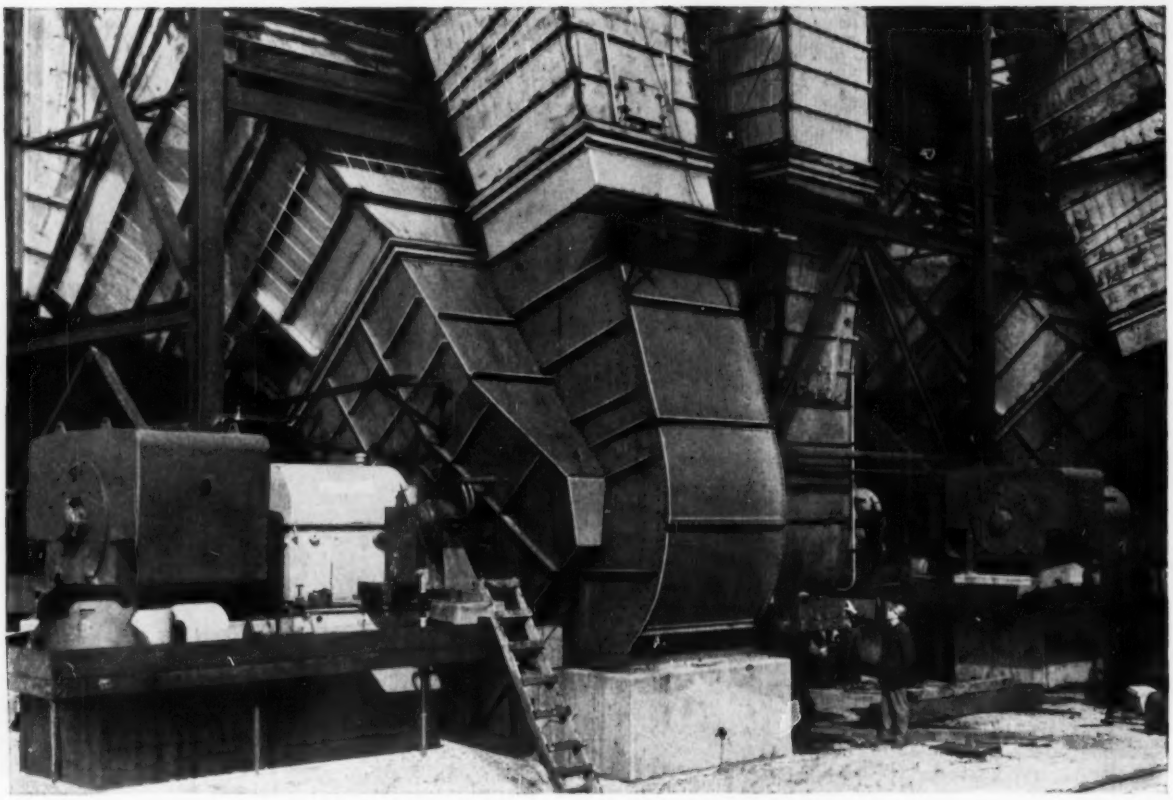
## When home building means line building

# Put Graybar on your construction staff

As residential areas spread outward from towns and cities and your load demands build up, call on Graybar for maximum help. A telephone call to your nearest Graybar warehouse or office puts our staff to work for you. Whether you're building new lines, adding more feeders or increasing feeder size, Graybar can supply the materials, equipment and supplies you'll need. In emergencies, or for regularly-scheduled shipments, count on prompt deliveries of anything and everything you need for pole-line maintenance and construction . . . via Graybar. 712

CALL **GraybaR** FIRST FOR

GRAYBAR ELECTRIC COMPANY, INC., 420 LEXINGTON AVENUE, NEW YORK 17, NEW YORK, IN OVER 130 PRINCIPAL CITIES



## HOW DO YOU SELECT MECHANICAL DRAFT FANS ?

By price alone? Undoubtedly not because proper fan performance cannot be obtained by cut-rate methods. It must be engineered and built to a standard, not a price.

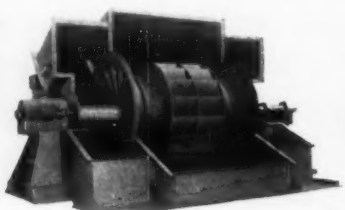
"Buffalo" Mechanical Draft Fans are built to an engineering standard with over 80 years experience and hundreds of installations to back it up. This engineering experience combined with "Q" Factor* construction makes the complete line of "Buffalo" Mechanical Draft Fans a best buy in the long run.

Be sure to phone your "Buffalo" Engineering Representative when you want reliable, high efficiency, long life mechanical draft fans.

*The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

Type CR
Radial Blade Fan.

Type BLH
Backward Curve Fan.



Type BA
Airfoil Fan.

"Buffalo"

**BUFFALO FORGE COMPANY**

Buffalo. New York

Buffalo Pumps Division • Buffalo, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

# New Extendo Fiberglass "Hot Stick" Locks in 5 Positions

*New positive locking mechanism on each section gives new versatility to Extendo "Hot Stick" . . . lets maintenance men perform more routine tasks, faster and safer.*

**FEATURES**

- Sections lock or unlock with twist of wrist . . . yet will take hundreds of pounds of direct pressure.
- Can be ordered with only tip-top section having locking mechanism.
- Lightweight . . . weighs under ten pounds.
- Telescopes from 4½ feet to required length . . . compact, easy to store.
- Non-conductive—tested to 100 KVA per foot by Independent Testing Laboratory.
- Available in 16, 20, 24 and 28 foot lengths.
- Universal head takes standard "fit-on" tools.

Called by many the biggest improvement in line-handling and maintenance tools in years, the Extendo Locking "Hot Stick" is lightweight, easy to carry and compact. The Extendo "Hot Stick" has been proven in the field by hundreds of utilities. The new snap action locking mechanism locks each section securely for push-pull operations. Sections lock in 4 foot increments. Collars prevent dust, dirt, or grit from entering joints, extending life of the hot stick.

**Orchard Industries, Inc. • Hastings, Michigan**

## *Order Today*

**To: Orchard Industries, Inc., Dept. E**
**Hastings, Michigan**

Please send me the following Locking Hot Sticks (indicate quantity next to square you've checked)

- ☐ ___ 16′ Extendo Locking Hot Stick . . . . . $50.00 ea.
- ☐ ___ 20′ Extendo Locking Hot Stick . . . . . 66.00 ea.
- ☐ ___ 24′ Extendo Locking Hot Stick . . . . . 81.50 ea.
- ☐ ___ 28′ Extendo Locking Hot Stick . . . . . 98.50 ea.

Prices FOB Hastings, Subject to Change

Company Name _____

City _____ State _____

By _____ Position _____

# HELPING FLORIDA ATTRACT NEW INDUSTRIES

ABUNDANT, DEPENDABLE ELECTRIC POWER is one of the strongest advantages an area can offer in seeking new industries—as Florida, one of the nation's fastest-growing states, discovered long ago. ¶ Florida Power and Light Company's expansion program has given real meaning to this advantage. After more than doubling capacity of its system in the previous 10 years, the company began another expansion program in 1956 by increasing capability of its Lauderdale steam plant from 96,000 to 426,000 kilowatts. ¶ Even before the new units at Lauderdale went into service, engineering was well advanced and construction started on a new steam plant at Port Everglades. First unit in this 480,000-kw plant is a 240,000-kw generator scheduled for completion next year. A second identical unit is planned for 1961 operation and the plant is designed for ultimate expansion to 1,000,000-kw capacity.

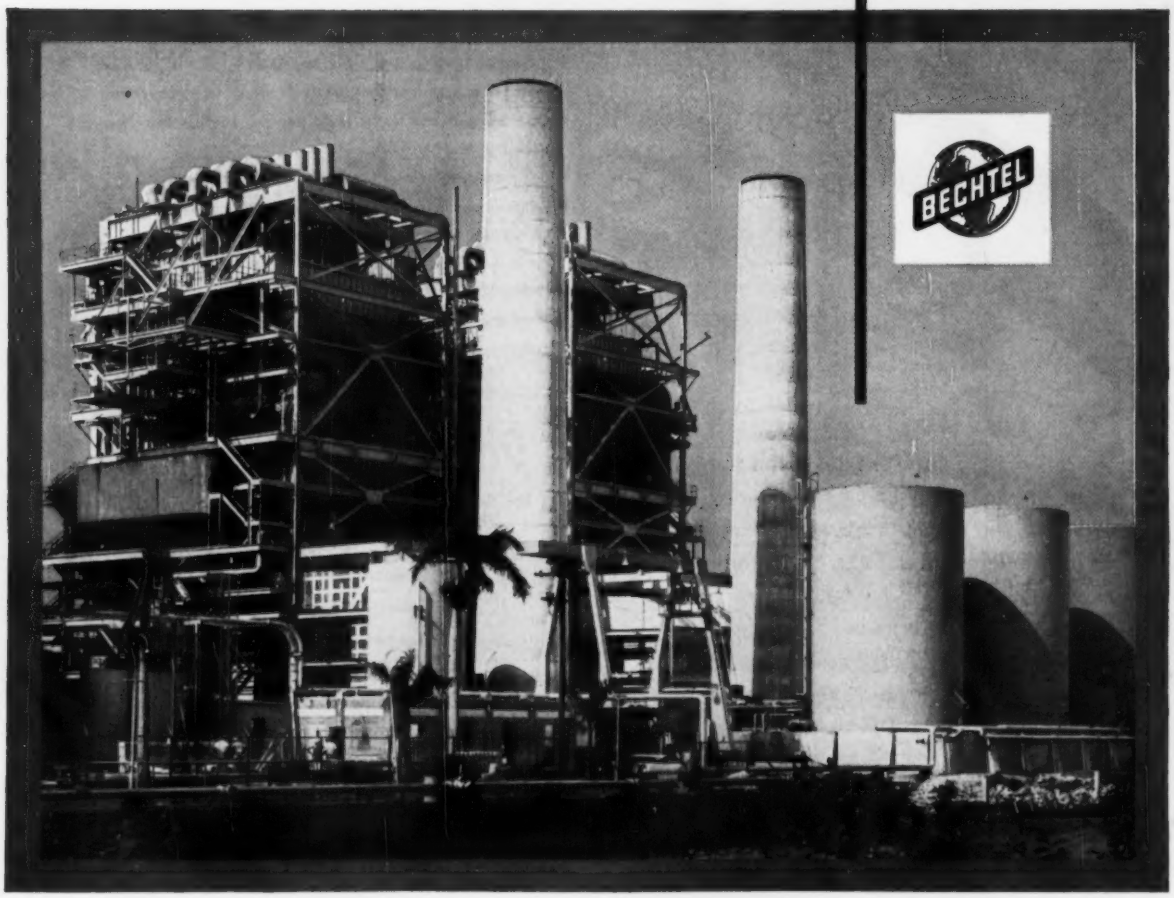
*Responsibility for design, engineering and construction of the Lauderdale expansion and the new Port Everglades plant was assigned to Bechtel, working closely with the company's staff.*

## BECHTEL CORPORATION

*Engineers and Builders for Industry*

SAN FRANCISCO • Los Angeles • New York • Houston

CANADIAN BECHTEL LIMITED • Toronto



*new look*

EXTRA HIGH STRENGTH

LOCKE CAT. NO. 51444

CAP & PIN UNIT

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

# NEW CAP & PIN insulator has unexcelled strength, plus 5 bonus benefits

**1. Increased arcing distance**

**2. More effective leakage distance**

**3. Improved flashover protection**

**4. Reduced stock quantities**

**5. Lower replacement cost**

The new Locke* Catalog No. 31444 cap and pin switch insulator has been specifically designed to meet your future needs. Selected for use in the 650 KV stations of Project EHV, this new unit provides twice the cantilever strength of presently available standard cap and pin insulators. Compare the *bonus benefits* with any other extra high strength unit on the market—conventional or post.

### INCREASED ARCING DISTANCE

The first *extra high strength* stacking unit to meet rated arcing distance established by EEI-NEMA for all standard BIL's.

| BIL | Standard Arcing Distance | Locke 31444 | Stacking Post ** |
|---|---|---|---|
| 550 KV | 44 in. | 44 in. | 39 in. |
| 650 KV | 47 in. | 47 in. | 45 in. |
| 750 KV | 59 in. | 59 in. | 51 in. |
| 900 KV | 74 in. | 74 in. | 64 in. |
| 1050 KV | 88 in. | 88 in. | 76 in. |
| 1300 KV | 103 in. | 103 in. | 90 in. |
| 1470 KV | 117 in. | 117 in. | 102 in. |

*Convenient comparison rule—Locke Catalog No. 31444 insulators offer 1" additional arcing distance per 100 KV of BIL.*

### MORE EFFECTIVE LEAKAGE DISTANCE

Time proven shell arrangement of 31444 provides protected and effective leakage distance. Spacing between shells designed to prevent cascading under most severe rain-fall. Makeshift rain shields *positively not required* to prevent bridging of hoods by drip stream.

### IMPROVED FLASHOVER PROTECTION

Laboratory and field tests prove 31444's ability in disconnect switch application to easily meet AIEE Standard (No. 22, paragraph 23-310) "—capable of withstanding between live parts voltage test of 10 per cent in excess of maximum voltage tests which they shall withstand to ground." A *plus* protective feature offered by cap and pin design.

### REDUCED STOCK QUANTITIES

Regardless of system voltages, storekeeper need *stock only one* style extra high strength insulator. Contrast this with post requirements—special top unit, special center unit, and special bottom unit for each voltage level. Hold your stock to an absolute minimum, order Locke catalog number 31444.

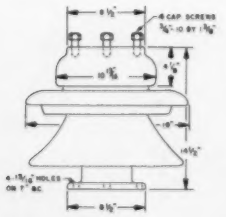
### LOWER REPLACEMENT COST

The 31444 provides lowest possible replacement costs for extra high strengths. Single unit replacement represents only one-fifth to one-eight total cost on 5 to 8 high stacks. A single replacement of posts represents one-third to one-fourth of total stack cost. In addition, 31444's light weight and convenient handling means reduced replacement labor costs.

Specify the new Locke Catalog No. 31444 insulator in gray or brown. For more information about the *new look* in high strength and extra high strength stacking insulators, contact your Insulator Department representative or write to Insulator Department, General Electric Company, P. O. Box 57, Baltimore 3, Md.

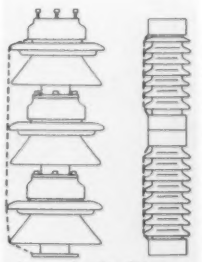
* Trademark General Electric Company

** Published rated values by manufacturer

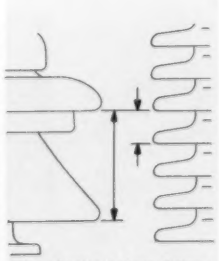


**Unit Characteristics:**

| | |
|---|---|
| Tensile Strength, Lbs. | 40,000 |
| Torsion Strength, Inch Lbs. | 120,000 |
| Compressive Strength, Lbs. | 100,000 |
| Net Weight, Lbs. | 125 |

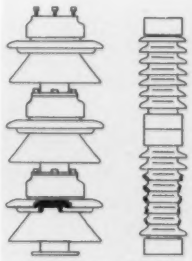


*Increased arcing distance*



*More effective leakage distance*

*Reduced stock quantities*



*Lower replacement cost*

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

# The Electrical Week

**FUTURE NEWS ▶** **House Interior Committee plans to vote this week** on Gubser-Utt bills to authorize private development at Trinity by Pacific G&E.

**LATE NEWS ▶** **FPC orders NY Power Authority** to operate its St. Lawrence project in compliance with International Joint Commission's requirements for water levels on Lake Ontario and St. Lawrence. It also orders Niagara Mohawk to show cause why it has not violated Federal Power Act by failing to follow certain reporting and accounting procedures involving bookkeeping for $49 million as fast tax write-off.

**AEC is inviting rural co-ops and publicly-owned utilities** to submit proposals for cooperative construction with the government of a 16,500 ekw nuclear power plant under the reactor development program.

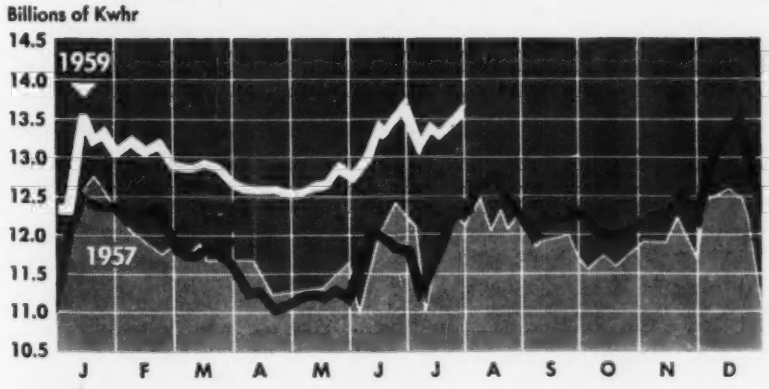
**Weekly output hits record 13,775,000,000 kwhr** for the week ended Aug. 1. Previous high was 13,749,000,000 kwhr registered for the week ended June 27 (see chart below).

**Columbus & Southern Ohio Electric gets PUC approval** to up rates by about $3.4 million annually . . . Missouri Utilities asks PUC okay to raise rates by $608,157 a year . . . Union Light, Heat & Power asks Kentucky PSC approval to up rates $969,000 a year.

**Retiring ECAP account exec Ed Dunning to write feature column** for utility employee magazines. The column, to stress merits of American private enterprise system, will begin in October.

**Management changes** . . . Colorado Central Power: J. E. Wilson to vp-commercial; Boston Ed: J. P. Healey to vp and general counsel; Florida Public Utilities: J. L. Terry to chairman and J. K. Roberts to president and general manager; and Clay C. Boswell, president of Minnesota P&L becomes chief executive officer.

## WEEKLY POWER OUTPUT—UP 9.2% (Week ending Aug. 1), Kwhr 13,775,000,000




Per Cent Change From Previous Year

| | July 18 | July 25 | Aug. 1 |
|---|---|---|---|
| Total U. S. | + 9.4 | +10.2 | + 9.2 |
| New Eng. | + 8.1 | +13.3 | +10.5 |
| Mid. Atlan. | + 6.6 | +14.3 | + 9.9 |
| Cent. Ind. | +11.8 | +10.7 | +10.2 |
| West Cent. | + 8.3 | + 8.5 | +10.6 |
| Southeast | + 5.7 | + 7.2 | + 6.0 |
| South Cent. | + 5.3 | + 1.0 | + 0.4 |
| Rocky Mount. | +10.3 | +14.0 | +15.1 |
| Pacific | | | |
| NW | +20.0 | +20.0 | +19.1 |
| SW | +17.9 | +16.3 | +14.3 |

Seasonally Adjusted Index 253.6

Week Ago 252.2 Year Ago 233.7

Source: Edison Electric Institute

# Preview of this Issue

**EVENTS ▶** **Benson and Ellis are at it again.** At the recent annual meeting of the Virginia Assn of Electric Cooperatives, the Agriculture Secretary and the general manager of National Rural Electric Cooperative Assn refought the battles of (A) 2% money, and (B) a co-op-owned national credit bank. Result: No casualties, no compromises, and no progress **(p 44)** . . . A Congressional probe into co-ops serving larger than the legal 1,500-population towns may be in the offing **(p 44)** . . . Fifth annual report of United Kingdom Atomic Energy Authority received a bit cooly **(p 45)** . . . The nuclear power ship Savannah may hold within her complex hull a few atom and steam plant lessons for the utility industry **(p 45)**.

**SPECIAL REPORT ▶ INDUSTRIAL ELECTRICAL SYSTEMS**

**Industrial electrical systems are engineering news this week.** Industrial plants today are moving toward greater uniformity and power system design standardization **(p 65)** . . . Who are the engineering groups, inside the plant and out, which foster these trends, and to what extent do they participate in plant design? **(p 68)** . . . These are the matters reported in EW's survey of industrial electrical systems. A few others: How can engineers exploit the transformer dollar? How are distribution voltages selected? The survey gives 19 tips on the problem of a plant's protective relaying system **(p 84)**.

# Politics and Public Power

### HEADWATER BENEFITS: PROS & CONS

The proposed legislation to amend the Federal Power Commission's rules for coordination of hydro power operations goes to the heart of the basic differences between federal and non-federal power development.

In recent hearings before the Senate and House commerce committees, private and some non-federal public power leaders called the bills fair, equitable and necessary; pro-federal power spokesmen hit the legislation as a giveaway and unneeded.

The bills (HR-5309, S-2262 and S-1782) would permit "voluntary" coordination agreements between any power systems—principally within basin systems. And they would require federal systems to pay for any improved hydro operations created by upstream reservoirs. At present, these payments (often called headwater benefits) are a one-way street: non-federal systems are required to pay, but the federal systems are not.

Sponsors of the legislation point out that it could increase firm power output in the Columbia River basin by 500,000 to a million kw without any new construction.

Willard Gatchell, FPC general counsel, says the measures "proceed upon the plain principle of fairness and equity in placing all electric consumers on an equal footing," private, public or federal. He adds that "equally important . . . is the principle that full coordination and integration of separately owned power facilities is in the public interest."

"It is almost incredible to me," testified Montana Power Co VP Sam Chase, "that anyone should oppose a bill which will increase available hydro-electric power without additional cost."

**PROCUREMENT & PRODUCTS** ▶ **Will steel prices go up?** Not if a "voluntary" agreement is reached with the union, says U.S. Steel's Roger Blough . . . Looks like no strike in the aluminum industry . . . GE cuts prices on current-limiting fuses . . . TVA to sell Colbert Plant fly ash to Dixie Fly Ash Corp who will sell it to cement product producers **(p 54).**

**MANUFACTURERS** ▶ **Ohio Brass opens plant to make Futura suspension insulators** . . . The 12,000-th transformer made by GE's medium transformer dept goes on the line of Utility Service Board, Jasper, Ind. Unit completes a three-year expansion program by the utility **(p 56).**

**MANAGEMENT** ▶ **A new objective approach to rating subordinate managers** is well on the way to getting a serious tryout by five utilities. The system uses written job-performance standards instead of personality traits. Its proponents claim it gives more accurate ratings, and also clarifies what's expected on the job, for both the supervisor being rated and his boss. For details, and a sample of the standard for line foremen, turn to **p 105.**

**SELLING** ▶ **Chart of EEI Sales Division committee chairmen in** easy to clip and save form . . . Latest in electric heating and cooling **(p 111).**

Even Sen James Murray, a strong federal power advocate, questioned how the federal government could "conscionably refuse to pay our non-federal producers and private utilities for the benefits which they confer upon the federal government (in the form of improved operations at federal dams) while at the same time authorizes payments to Canadian organizations for identical benefits"—through the International Joint Commission.

However, federal power backers had their say also . . .

"Double giveaway . . . a bad bill," says Sen Wayne Morse. He opposes any requirement for federal dams to reciprocate in headwater benefits payments by challenging the "assumption" that non-federal interests have equal rights on rivers.

Both Alex Radin of American Public Power Assn and Gus Norwood of Northwest Public Power Assn oppose the measures. Radin emphasizes that the federal government should not achieve coordination by paying a "bonus" to private companies which "make a profit from use of a federal license." Radin and Sen Clair Engle claim one bill would make coordination agreements mandatory, although Gatchell had denied this.

Three PUD's — Pend Oreille, Grant County and Chelan County—testified for the bills, against APPA and NWPPA. They claim legislation is needed to permit their systems to work out coordination with Bonneville, because present rules leave them "helpless" to reach agreement.

Don't look for a vote on these bills this year or even in '60. Their principal role now seems to be to bring more and more under public scrutiny the merits of federal power development.

**Accurate weather forecasts are particularly valuable** when the weather varies substantially from normal. Predictions covering 18 individual marketing areas for each month for the entire 1958-59 heating season were presented in April, 1958 by Dr. Irving P. Krick, Denver, to Shell Oil Co. For the nation and season as a whole, the predictions scored 99% in forecasting total degree-days (measured on a weighted basis). Outstanding was the prediction that December, 1958 would be much colder than normal. It was the coldest December in 33 years. **Petroleum Week, June 26, 1959.**

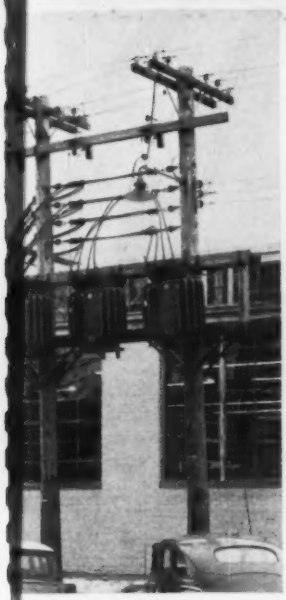
**Continued success of rural electric cooperatives** will depend upon the building of a sound financial foundation. Cooperatives now are strong and mature enough to stand on their own feet. While interest rates in existing financial arrangements should not be disturbed, the 2% rate does not cover the present cost of money to the government. To develop a permanent financing plan that eventually can result in farmer-owned-and-operated lending agencies, I am "ready to meet with representatives of your national association to discuss these problems on a man-to-man basis." **Ezra Taft Benson, Secretary, Dept. of Agriculture, before the Virginia Assn of Electric Cooperatives, Roanoke, Va.**

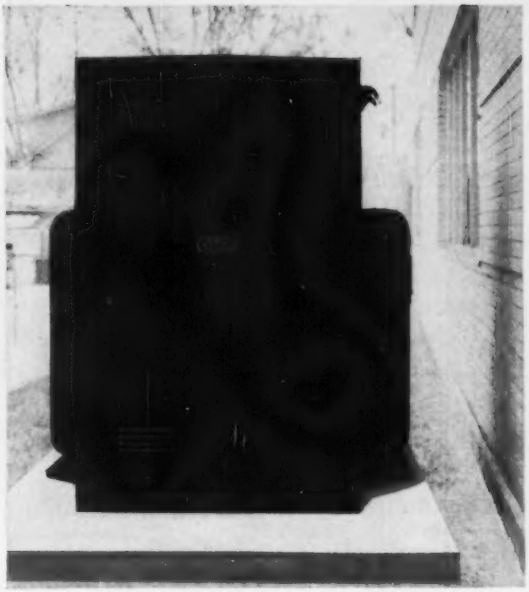
## NUCLEAR NOTES

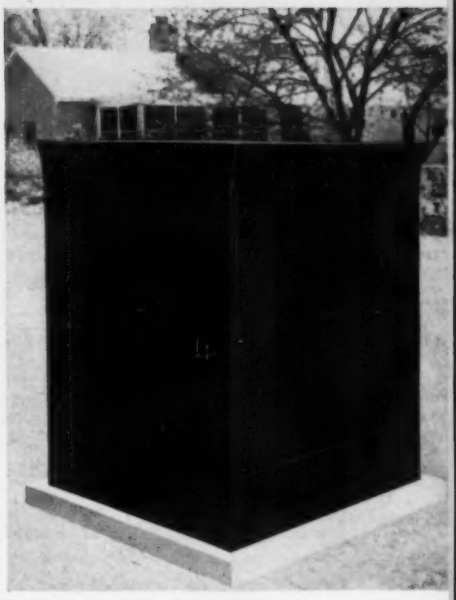
**Site for Canada's first large-scale 200 Mw CANDU nuclear power plant will** likely be near Kincardine, Ontario on the Eastern shore of Lake Huron. Other sites are being considered but Kincardine is favored. Ontario Hydro will purchase power generated and staff the $60 million station scheduled for operation in 1964. Its heavy water-cooled and moderated reactor is to be fueled with uranium oxide slugs sheathed in Zircaloy 2. Burnup rate is 8,100 MWD per metric ton of contained uranium. Preliminary estimates put total energy costs at 5.78 mills. **Ontario Hydro News and Financial Post, Toronto.**

**GE's unexpired contract with AEC for operation of Hanford** has been revised and renewed. The previous cost-plus fixed-fee contract running to 1961 was for $2,650,000 yearly. The new fee is for $2,196,000 because the contract covers only Hanford. The previous one covered operations of Knolls Atomic Power Lab in Schenectady. GE's turbine department will continue to operate the Knolls facility as a separate operation under terms of the old contract.

# om THIS.....to THIS.....or THIS!







**APPEARANCE** is one important reason for going from overhead to underground construction. Today, the utilities working with Line Material have equipment available such as this L-M 12 kv, 300 kva, three-phase Pad-Mount transformer to replace the older-style pole-mounted bank.

**ANOTHER SOLUTION** to unsightly overhead banking is the Line Material Transclosure. Originally designed for either standard single or three-phase, pole-type distribution transformers, it can also be used singly or ganged to provide as much space as is needed for switching and protective devices.

# New Developments Continue L-M Leadership in Underground Distribution Equipment

## L-M Engineers continue development of new products to help utilities find the most practical, economical solutions to the growing pressures for underground distribution.

By R. C. KIRK, Vice President
Research and Engineering, Line Material Industries

As utility men know, there are growing pressures in many areas, to install distribution lines underground. These pressures come from the public, from subdividers and builders, and from communities.

### New L-M Developments Help Cut Cost

Recognizing that these pressures are continually increasing, Line Material over three years ago, began working with utilities to produce equipment that would economically and practically solve this problem. The result is additional equipment from L-M which offers substantial reductions in underground distribution system costs, namely:

**1 The Pad-Mount Transformer**—a distribution transformer with a self-contained enclosure for terminals, switching and protective equipment that can be mounted on a ground-level pad or on a rooftop.

**2 The Transclosure**—a ventilated steel enclosure, also mounted on a ground-level pad, for pole-type distribution transformers, protective and switching equipment, load transfer equipment; can also accommodate service meters and telephone equipment.

**3 The Power Pedestal**—a stake-mounted pedestal for above-ground connection and termination of underground secondary services and secondary mains.

### Underground Distribution Headquarters

Because of our extensive work in this field we logically consider Line Material as "Underground Distribution Headquarters." We would be happy to share our knowledge with you and would appreciate the opportunity of showing how our products can provide a practical and economical solution to your underground problems. Contact your L-M Field Engineer, or write me direct at Line Material Industries, Milwaukee 1, Wisconsin.

409

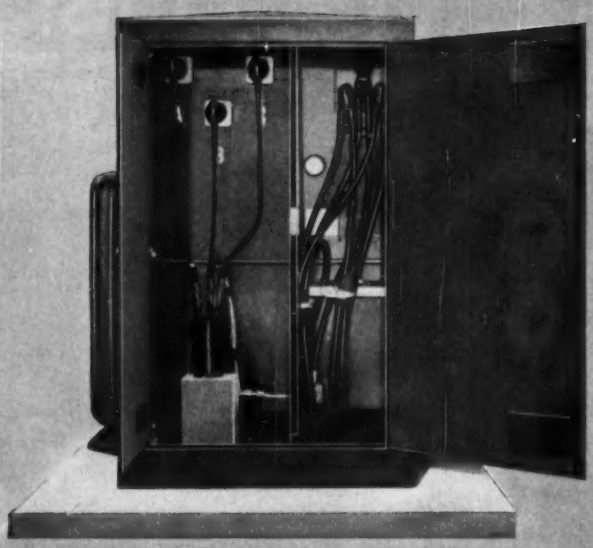
**LINE MATERIAL® Industries**

McGRAW-EDISON COMPANY

McGRAW EDISON

## Underground Distribution Headquarters

DISTRIBUTION TRANSFORMERS • KYLE RECLOSERS AND OIL SWITCHES • FUSE CUTOUTS AND FUSE LINKS • LIGHTNING ARRESTERS • POWER SWITCHING EQUIPMENT
PACKAGED SUBSTATIONS • CAPACITORS • REGULATORS • OUTDOOR LIGHTING • LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE AND CONDUIT

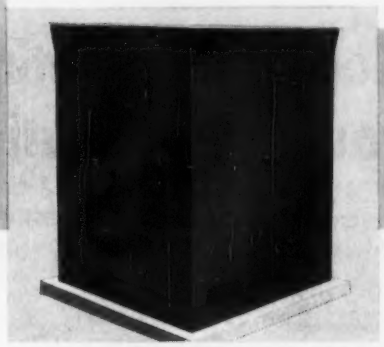


THIS 300 kva, 12,000 volt three-phase unit is installed at a small industrial plant. Note that the primary compartment at left can be closed for safety when work is being done on the secondary.

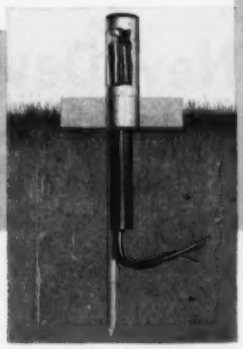
LINEMAN is about to close and lock door. Note the neat, compact appearance of the unit, which makes it ideal for residential subdivisions, where low shrubbery can hide the unit completely.

SINGLE PHASE 50 kva, 12,470 grounded Y/7200-volt L-M Pad-Mount Transformer. Primary compartment is closed, at left. At right is secondary compartment, with insulating barrier separating it from primary section.

## OTHER NEW L-M UNDERGROUND DISTRIBUTION EQUIPMENT



L-M TRANSCLOSURE(TM), a convenient, multi-size, rainproof, ventilated steel housing for pole-type distribution transformers, protective equipment, reclosers, load transfer equipment, etc. Provides above-ground accessibility for underground services.



L-M POWER PEDESTAL, for above-ground connections of buried secondary services. Removable dome; raintight; tamperproof, with provision for padlock. Ask L-M Field Engineer or write for bulletin on styles available.

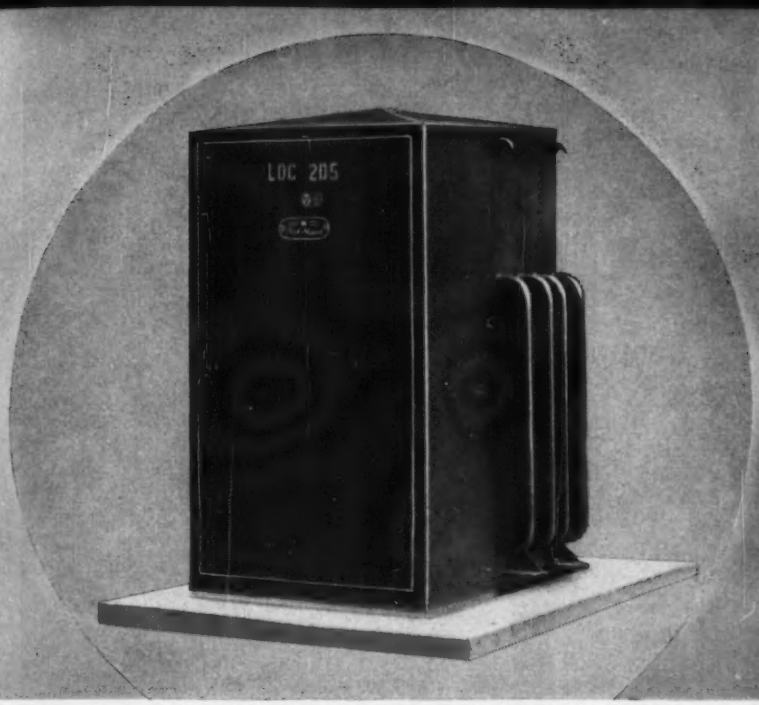
THIS TRUCKLOAD of L-M Pad-Mount Transformers is part of a 68-unit order being installed at a large trailer court in the Middle West. Quantity production and delivery like this have enabled L-M to make drastic reductions in the cost of this specialized, highly efficient transformer.

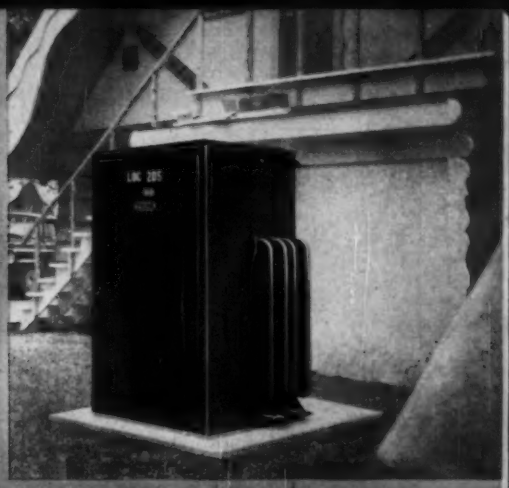
406

### Nothing Else Like It!

The L-M Pad-Mount Transformer is available in single-phase through 167 kva, and three-phase through 500 kva in all distribution voltages.

Get complete information on how the LM Pad-Mount Transformer will help you simplify *your* underground construction problems. Ask the L-M Field Engineer for Bulletin DT8. Or write me at Line Material Industries, Milwaukee 1, Wisconsin.



L-M 225 kva three-phase Pad-Mount transformer provides underground service for Santa's Village, a "kiddie park" near Dundee, Illinois. Note that welded panels between cooling tubes and tank prevent attaching guys and ropes. This identical cubinet also accommodates a 500 kva Pad-Mount transformer for future load growth.

# New L-M Pad-Mount Transformers Are Practical For Underground Distribution

## Developed by L-M in cooperation with engineers of major utilities to meet specific requirements for underground distribution systems. Provide advantages not available in other types.

By A. R. WAEHNER
Director of Transformer Sales
Line Material Industries

Economical underground distribution is a vital topic of study and discussion today by leading system-planning engineers. Recognizing the future developments, load-growth opportunities, and other factors placing pressure on utilities, Line Material has cooperated with utilities to develop equipment that will help make underground distribution simpler, more efficient, and more economical to install and maintain.

**L-M's Outstanding Development . . .** One of the leading developments from this extensive cooperative research is the Line Material Pad-Mount Transformer. This outstanding unit has already been thoroughly tested. It is used by a number of utilities, including one of the largest in the country, where it has been in operation for about two years. It is proving highly successful, primarily because the design has been progressively developed to take full advantage of the opportunities afforded by newer, simpler methods of underground construction.

**Conventional or Self-Protected . . .** The L-M Pad-Mount Transformer is of Round-Wound® design, available in either conventional or self-protected, in single- or three-phase, in a tank specially designed for ground-level or roof-top mounting. A locked door covers the primary and secondary bushings. It can be completely hot-stick operated. There is an oil switch in the primary. A stand-off insulator for primary leads, mounted in the cabinet but not on the transformer, permits taking the transformer out of service when desired.

**Compartmental Design . . .** The compartments are so arranged that the primary section is completely isolated with a barrier of insulating material. This prevents access to the primary when working the secondary side. Door has rust-proof stainless-steel piano hinge.

**No De-Rating with This Unit . . .** The de-rating conventionally applied to transformers in buried or semi-buried vaults is not necessary, because the L-M Pad-Mount is a free-standing, above-ground unit, which takes full advantage of air circulation.

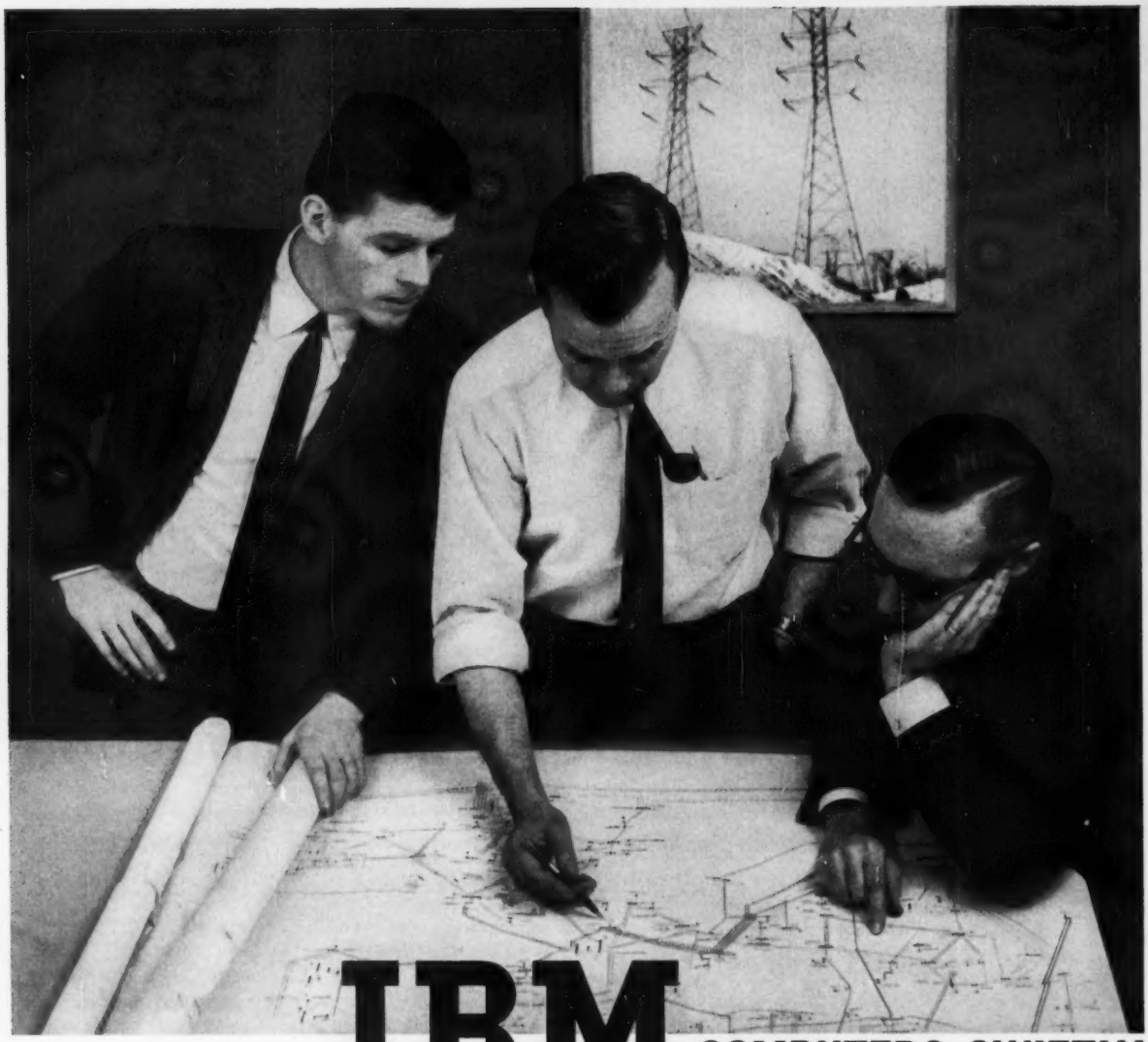
**Volume Results in Cost Reduction . . .** The original cost of this highly specialized, highly efficient unit apparently would be much more than even the most refined of the buried devices. However, volume production has enabled L-M to make drastic cost reductions. The L-M Pad-Mount is an extremely economical unit to buy and install in comparison with other systems.

**Easy to Install . . .** Installation is extremely simple. All that is needed is a concrete pad, with primary and secondary services brought up through fibre conduit. The bushings are so located that no sharp bends are made in the cable, thus assuring full life for the cable.

The cabinet may be separately shipped, mounted, and wired when underground services are installed in a subdivision. The transformer may be shipped later and easily attached to the compartment with four bolts.

**LINE MATERIAL® Industries**
McGRAW-EDISON COMPANY
McGRAW EDISON

*Underground Distribution Equipment*



# IBM® COMPUTERS SWIFTLY DETERMINE NEW TRANSMISSION LINE REQUIREMENTS

Today, for even the toughest problems in line design, transmission engineers are finding quick answers with IBM digital computers.

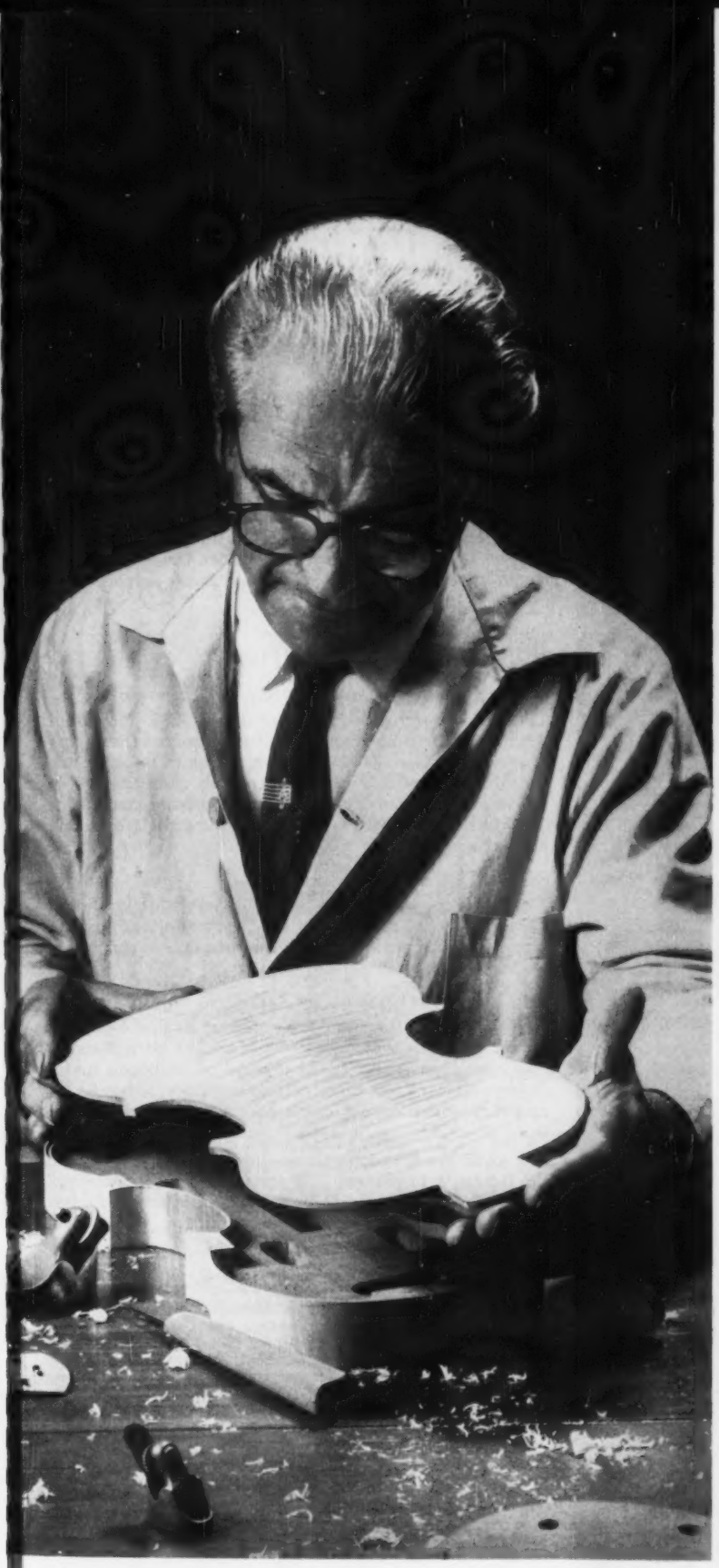
Basic line requirements, obtained from IBM digital load flow studies, represent one segment of computer usage in transmission systems. In addition, IBM computers ascertain self and mutual impedances; give most economical conductor sizes; make sag and tension computations and solve tower design problems. As a result, engineers are freed from routine calculations and are able to devote more time to creative systems planning.

IBM digital equipment offers the transmission engineer many advantages: accuracy sufficient for loss studies; no transcription errors; ability to study high and low voltage systems using a common MVA base; table look-up operations; fast logical decision functions; and immediate availability.

Not confined to special purposes, IBM equipment can be used by both Engineering and Accounting Departments.

IBM's more than 44 years of service and experience are available to you through your local representative.

**DATA PROCESSING DIVISION**
**INTERNATIONAL BUSINESS MACHINES CORPORATION, N.Y., N.Y.**



"When performance counts," says our artisan friend, "you look for skilled craftsmanship and the best materials. There can be no compromise with quality."

The same thing applies to treated wood products. At AMCRECO no detail is insignificant. Each step—from selection of growing timber to treatment of the wood—is carefully controlled for highest quality.

The results of this exacting care and craftsmanship are reflected in the decades of service-life that AMCRECO-treated structures provide.

Why not see for yourself how quality control can improve performance, by specifying AMCRECO on your next order for pressure treated wood products.

AMERICAN CREOSOTING CORPORATION

AMCRECO PRESSURE TREATED WOOD PRODUCTS

Louisville 2, Kentucky

Subsidiary of Union Bag-Camp Paper Corporation

# New Intermediate Type IVS Arrester Gives Proven Protection Against Severest Strokes

The experience of 37 years of valve arrester design and field application has made possible the new IVS intermediate class arrester with station arrester dependability. Incorporating many established Westinghouse LVS and station-type arrester features, the IVS is rated from 3 to 121 kv and offers high surge capacity in excess of 100,000 amps!

## Bonus Value Features

*Higher Creepage Values With Stronger Porcelain*

The new deep-dish skirts have up to 35% additional creepage, providing greater protection against the effects of contamination. 15% stronger porcelain housing has been made possible by a high-strength glaze that gives much greater cantilever strength. Self-supporting installations can therefore withstand many times the normal wind loading.

*Station-Type Mobilarc Gaps*

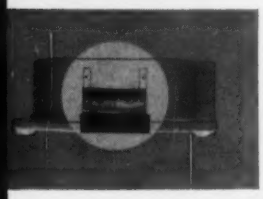
Time-proven, heavy-duty, station-type Mobilarc* gap elements spin the arc over the electrode, eliminating pitting and other damage . . . a plus value in this intermediate arrester line.

*Entire Arrester Hermetically Sealed*

Gap and valve elements are enclosed in a wet-process porcelain casing which is solder-sealed at both ends by the Westinghouse-patented process of soldering metal to porcelain. This positively eliminates entrance of moisture which would cause corrosion or radio interference.

Ask your Westinghouse sales engineer to demonstrate the Bonus Values of the IVS arrester, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-60976

*Trade-Mark

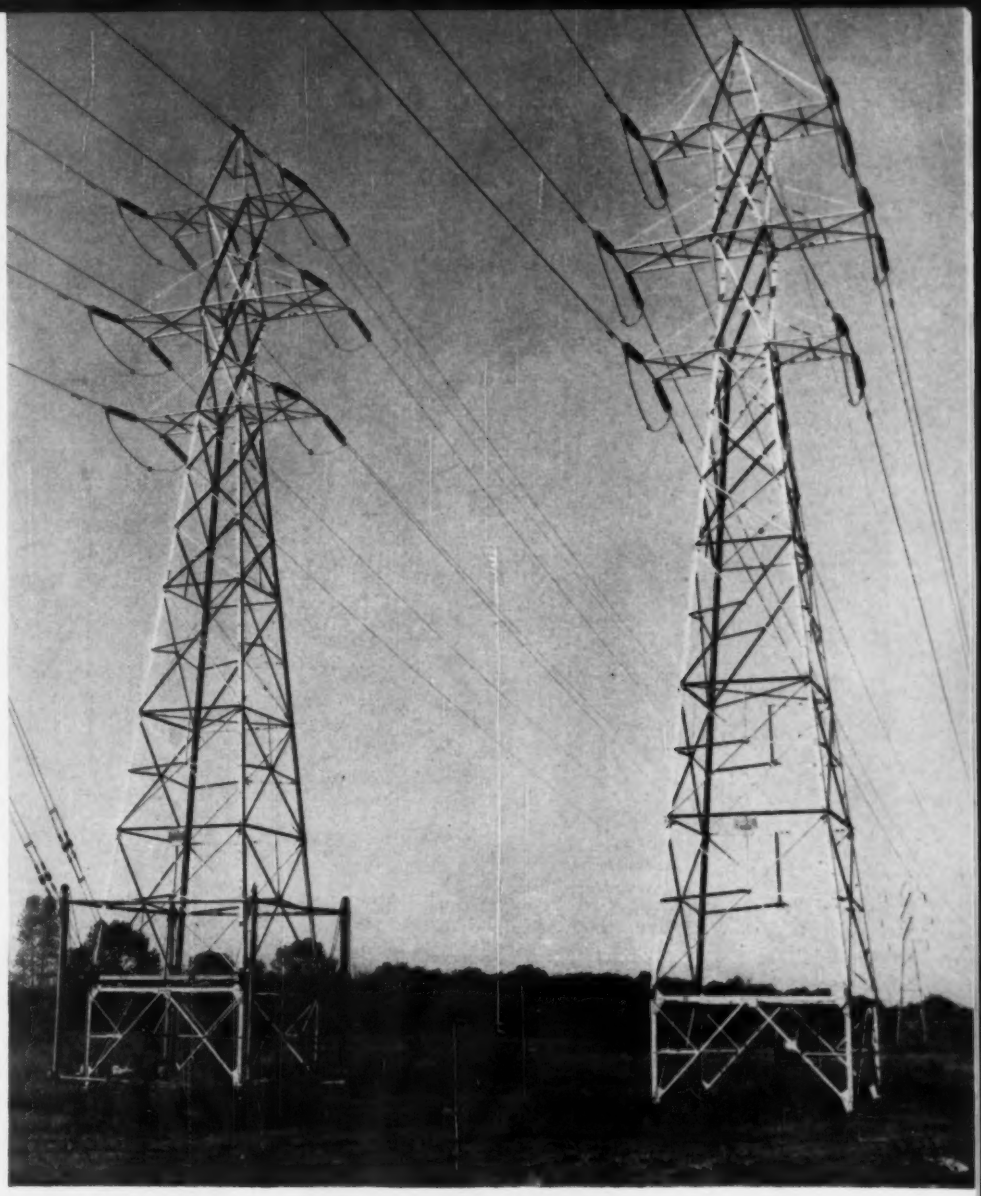


**Pressure Release . . .** In the remote event of a sustained, 60-cycle current flow through the arrester, the lead diaphragm pressure release operates, permitting the pressure to be vented. Pressure blows off the red cover plate, thus giving visual indication that the arrester should be replaced.

YOU CAN BE SURE...IF IT'S

**Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS



Typical of today's transmission problems, reconductoring was accomplished by Cleveland Electric Illuminating Company by raising many 33-year-old Blaw-Knox towers. When present program is complete, the company will have raised and reconductored 93 miles of double circuit lines.

# How Blaw-Knox Tower specialists can help you meet today's transmission problems

Because of growing electrical demands, many power companies are faced with the problem of modifying existing lines and designing new lines for the higher voltages of tomorrow.

Blaw-Knox tower engineers, with more than forty years' close cooperation with power companies in the solution of many different transmission problems, can bring practical assistance to bear on your particular problem.

If your project is one of modifying a present line for greater capacity within a limited right-of-way, or reconductoring, or if you are developing an extra high voltage grid, and need specific answers to tower design and anchoring problems, Blaw-Knox will be glad to help. Contact the Tower Sales Department, or you may wish to write for a copy of Bulletin 2570, outlining these engineering services. No obligation, of course.

**Transmission Towers**—Steel transmission towers custom built for each installation . . . multi-circuit and other special structures . . . guyed and self-supporting antenna towers for AM, FM, TV and Microwave, Antennas . . . rotating . . . Radar Radio Telescopes . . . Tropospheric Scatter and Ionospheric Scatter.

BLAW-KNOX

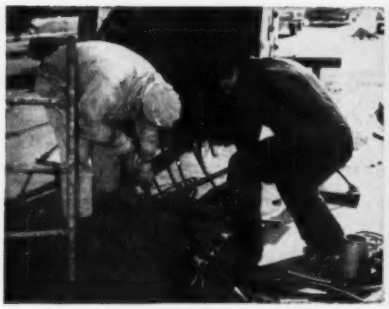
**BLAW-KNOX COMPANY**
*Blaw-Knox Equipment Division*
*Pittsburgh 38, Pennsylvania*

## *Power Boost with* **PARANITE®**

Consolidated Edison is meeting the challenge of mounting demands for electrical power with a systematic program of replacement and expansion. Selected to help carry this ever-increasing load in the Metropolitan New York area is Paranite "Network Power Cable" . . . one of the many Paranite products which backs up a reputation . . . "IF IT'S PARANITE IT'S RIGHT®"

### Why PARANITE "NETWORK CABLE?"

Paranite Network Cables are engineered, manufactured, tested and have been proven in installation to meet the severe demands of seasonal peak loads. The consistent performance of Paranite marks it as a product of close quality control!



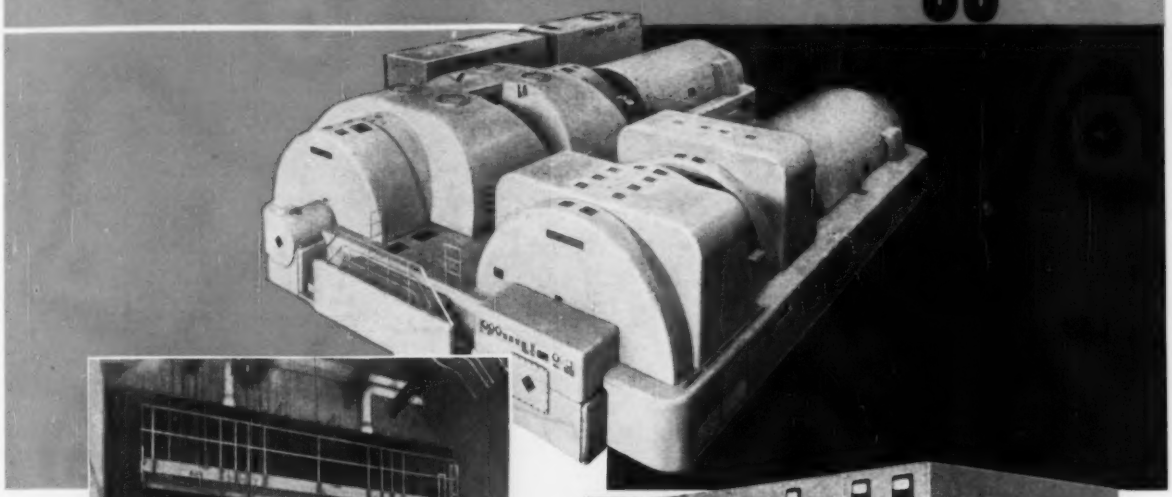
**PARANITE WIRE AND CABLE DIVISION**

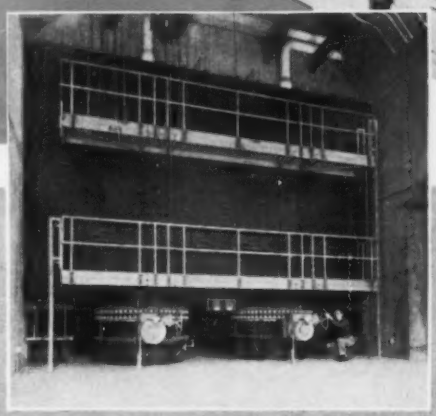
***Essex Wire Corporation, Fort Wayne 6, Indiana***

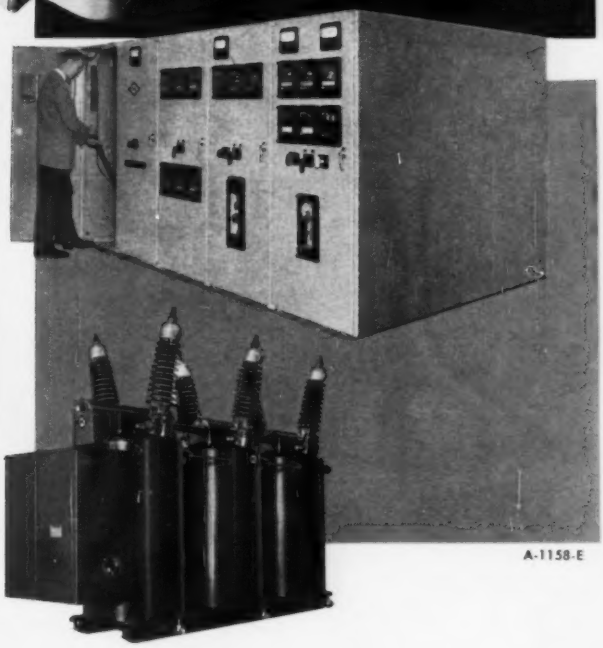
**MANUFACTURING PLANTS: Birmingham, Ala.; Anaheim, Calif.; Jonesboro, Ind.; Marion, Ind.; Tiffin, Ohio**

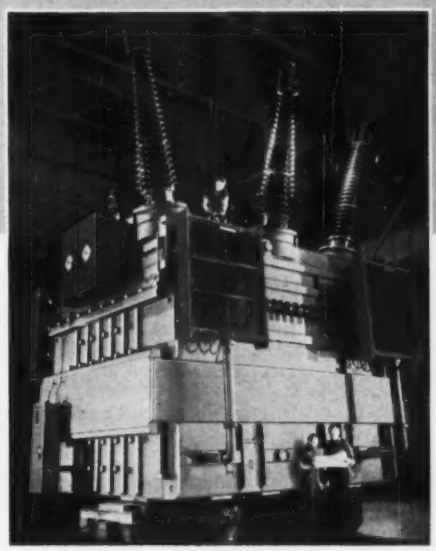
**Sales Offices in all Principal Cities**

ALLIS-CHALMERS modern line for '59









A-1158-E

# Modernize

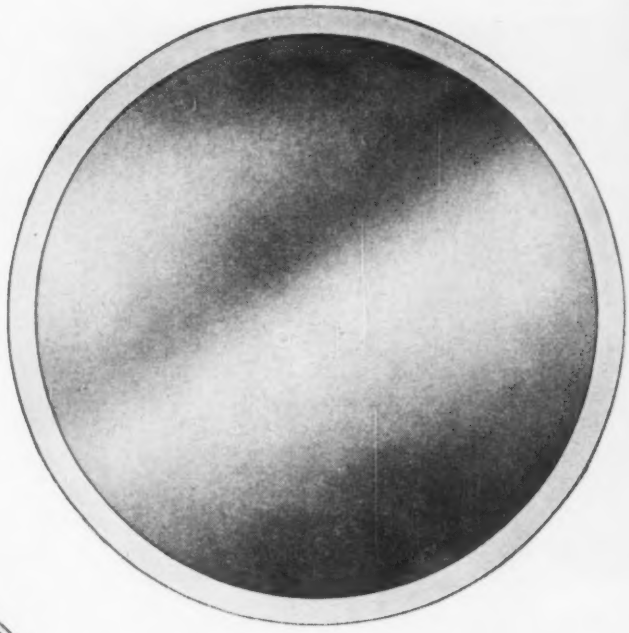
## to build system efficiency

A continuing program of electrical equipment modernization is one of the most successful approaches to cost reduction. The *degree* of cost reduction depends upon unit efficiency. Allis-Chalmers equipment has built a world-wide reputation for achieving *higher* system efficiencies created through research-born design advantages!

**ALLIS-CHALMERS**

*For detailed information on Allis-Chalmers efficiency-boosting advantages, contact your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.*

# New "D" coating for Bethlehem Strand...



## ... outlasts "A" coating 4 to 1

You can count on Bethlehem's new "D" bethanized coating for long service even in highly corrosive atmospheres because it is four times the weight of the old reliable "A" bethanized coating. The "D" coating, applied to the wires of Bethlehem strand by a special electrolytic process, is not only a heavyweight; it's also uniform in thickness.

With the addition of the ductile, 99.9 pct pure zinc "D" coating, Bethlehem now offers four weights of bethanized coating. The "A" coating, although the lightest, is adequate for most applications where atmospheric conditions are good; the "B" coating is twice as heavy; the "C" coating is three times as heavy.

Perhaps you'd like to know more about Bethlehem strand. Or you might like to know which coating weight will give you best results. If so, please feel free to get in touch with our nearest sales office.

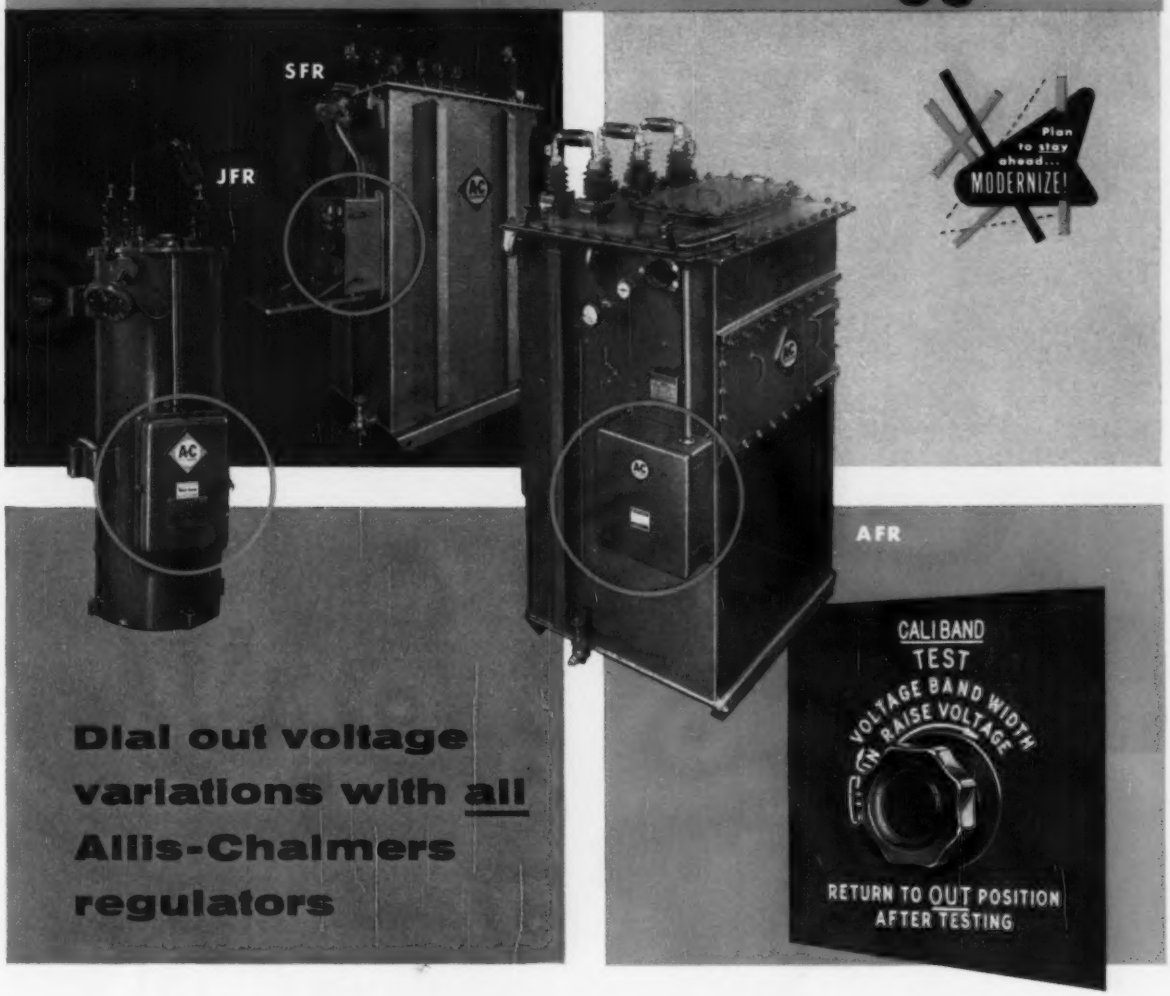
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

**BETHLEHEM STEEL**

BETHLEHEM STEEL

ALLIS-CHALMERS modern line for '59




**Dial out voltage variations with all Allis-Chalmers regulators**

**New Caliband regulator control gives you precise settings with a twist of the knob...ends customer complaints**

*Caliband* is an Allis-Chalmers trademark.

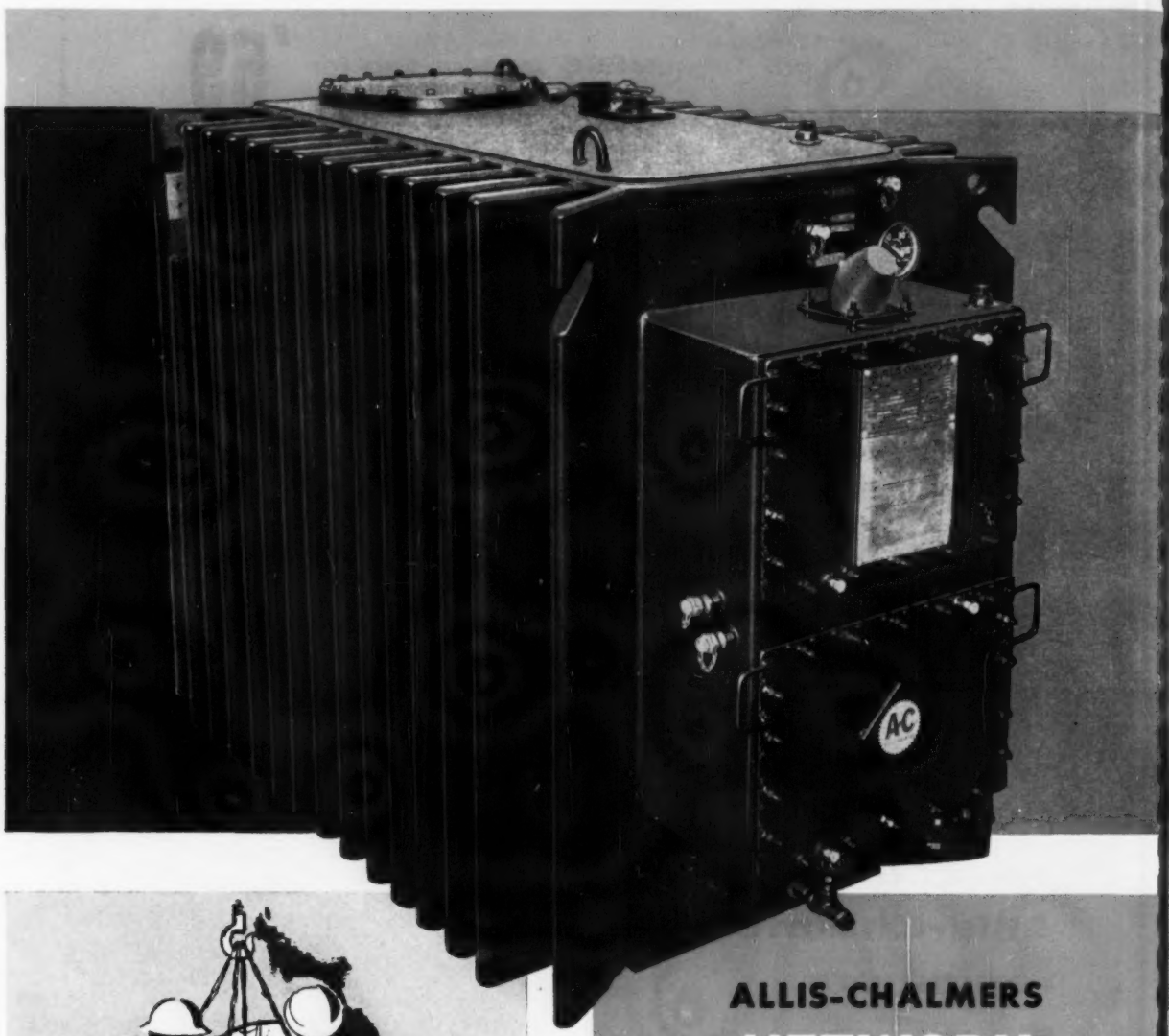
*Caliband* control gives you complete freedom to test and accurately set voltage level and band width. There's no interruption of regulated service, no changing of customer voltage. Just a simple twist of the knob does the job.

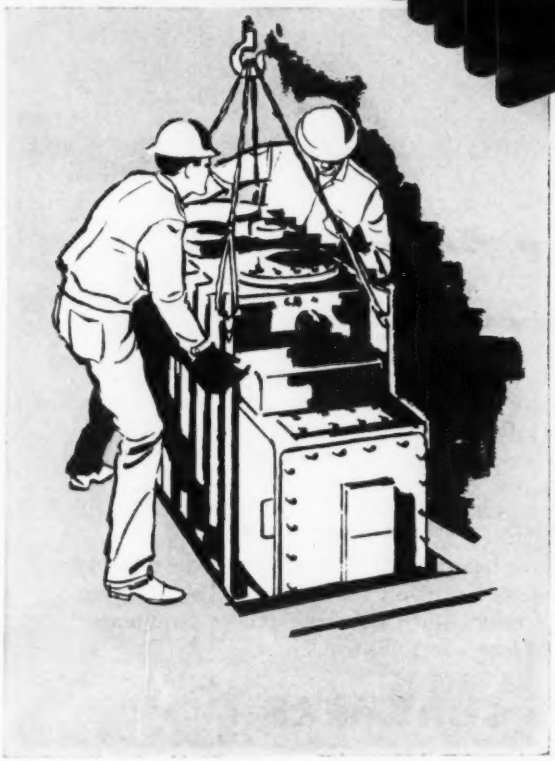
**CALIBAND control demonstrated**

A call to your nearby A-C office will bring an engineer and a *Caliband* control demonstration kit to your desk. Or, write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

**ALLIS-CHALMERS**
*Originators of 5/8% Step Regulators*

A-1156-E





**ALLIS-CHALMERS**

# NETWORK TRANSFORMERS

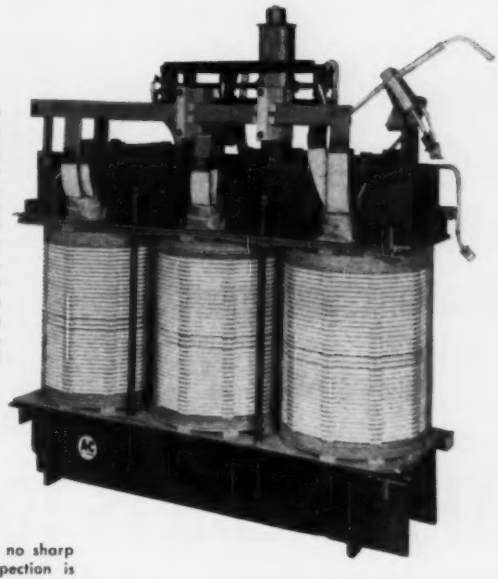
## Truly New for True Economy

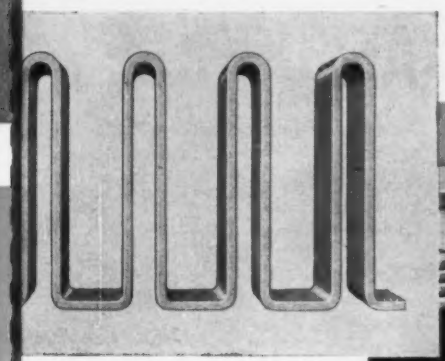
With equipment replacement costs increasing, it's more important than ever to demand maximum transformer value. When you buy that new transformer, look beyond the price tag for the advanced engineering that promises long-range economy. Insist on an assurance of bonus service years. Consider cost-cutting convenience in installation . . . in maintenance. In short, specify an Allis-Chalmers network transformer . . . the transformer that gives you everything that's new *now* . . . the transformer that will stay new for years to come.

## ALLIS-CHALMERS modern line for '59

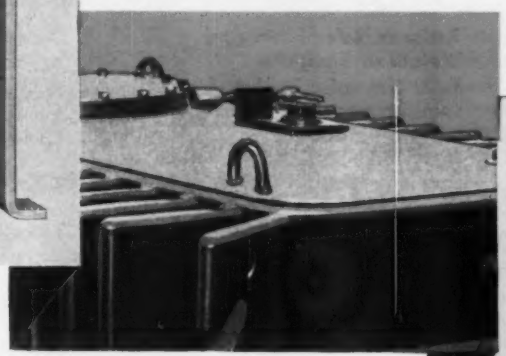
# Smaller Vault Requirements per Kva

**Compact core and coil assembly** has reduced overall size and weight by an average of 15%. As a result, increased kva may be installed in existing vaults. Sizable savings are realized in excavation, construction and rental costs. With smaller, lighter transformers to handle, work crew efficiency is improved. From the performance stand-point, the compact core and coil assembly provides greater resistance to surge conditions and short-circuit stresses. Lower exciting current and lower losses afford additional system economies.



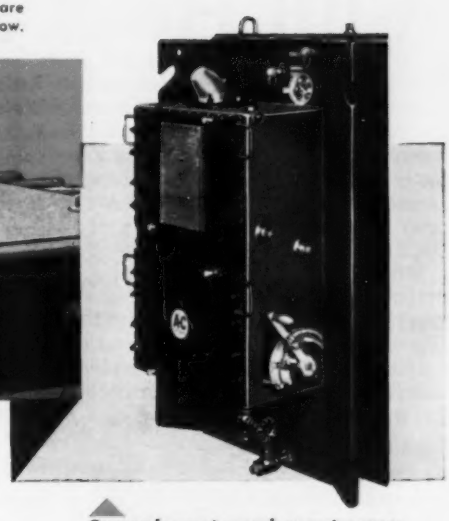


**Corrugated tank design** has no sharp corners or crevices. Visual inspection is quick and thorough. When repainting becomes necessary, all cooling surfaces are readily accessible with brush, spray or flow.



# and Simplified Maintenance

**Welding** does away with most bolted connections. This results in a surface that stays cleaner longer. Welded-on covers cut maintenance costs considerably by eliminating gaskets.



**Grouped easy-to-read, easy-to-operate accessories** — Allis-Chalmers pioneered the time-saving convenience of grouped accessories. The importance of this development is reflected in today's industry standards.

Plan to stay ahead... MODERNIZE!

*For detailed information, call your local Allis-Chalmers representative or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.*

A-C ALLIS-CHALMERS

A-1027-E

In high voltage transformers, other heavy duty electrical and electronic equipment...

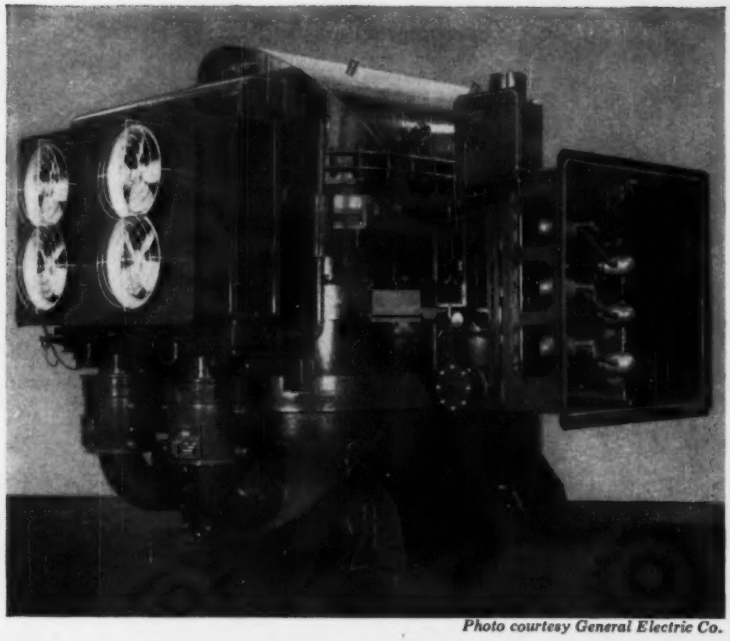


*Photo courtesy General Electric Co.*

# THE TREND IS TO GASEOUS INSULATION WITH B&A® SULFUR HEXAFLUORIDE

The trend in requirements for high voltage equipment is toward higher operating voltages, units of minimum size and weight, greater safety and lower maintenance costs. For these reasons, sulfur hexafluoride is being used to insulate a wide variety of electrical and electronic equipment.

Sulfur hexafluoride is not only the preferred gaseous dielectric—it has also proved superior to liquid insulation in many applications. For example, the use of $SF_6$ instead of oil to insulate high voltage transformers has the following advantages:

**High Dielectric Strength**

At atmospheric pressure, $SF_6$ has a dielectric strength 2 to 3 times that of air, nitrogen or carbon dioxide. This favorable ratio increases with pressure so that in the range of 2 to 3 atmospheres $SF_6$ has a dielectric value roughly equivalent to transformer oil.

**Efficient Over Wide Temperature Range***

$SF_6$ is stable in the presence of most materials of construction up to temperatures of about 150°C; remains a gas down to −63.8°C.

*Where extreme inertness to other materials is required or when service conditions involve temperatures in the range of 150°C to 250°C (or higher!), Baker & Adamson's Perfluoropropane ($C_3F_8$) is recommended.

**Reduces Noise Level and Weight of Equipment**

Both the noise level and weight of transformers can be reduced substantially by insulating with $SF_6$ rather than with a liquid. The low noise feature is particularly important where residences are nearby. Weight savings pay off for portable equipment and reduce installation costs for stationary equipment.

**Safe to Use**

$SF_6$ is non-toxic, chemically and physiologically inert, fire-proof and explosion-proof.

**Installation Savings**

Installation in fire-proof vaults is eliminated and bus runs can be shortened drastically due to closer proximity of transformer to generator.

Many of these advantages are also applicable to other commercial uses of sulfur hexafluoride, such as in:

**Interrupter Switches**
**Radio and Microwave Frequency Power Transmission**
**X-Ray Equipment**
**Audio Equipment**
**Cathode Ray Accelerators**
**Van de Graaff Machines**
**Television Filterplexers**
**Radar Duplexers**
**Gap Tubes**
**Switch Gear**
**Wave Guides**
**Airborne Electronics**
**Silicon Rectifiers**

Investigate all the advantages of B&A Sulfur Hexafluoride gaseous insulation *now*. Write for technical literature.

**BAKER & ADAMSON® Electronic Chemicals**

Allied Chemical

**GENERAL CHEMICAL DIVISION**
**40 Rector Street, New York 6, N. Y.**

*Lightweight, extremely pliable, made for all voltages, in all lengths—*

# NEW M-S-A® CURVED FINGER LINEMEN'S GLOVES REDUCE FINGER FATIGUE

**Linemen wearing new M-S-A Curved Finger Rubber Gloves** work safer, faster, longer, and more comfortably than ever before. There's ample space now between the well-rounded lengths of the fingers. This new design principle practically eliminates finger fatigue. The standard color of these gloves is black. A special glove may be had that is molded with a caution color underneath which shows when the black top is worn down.

**M-S-A® Leather Protectors** made of finest flesh side split horsehide with cowhide cuffs, wear smooth, dry out soft, and will not harden after exposure to water. Tailor-made exclusively to fit exact contour of M-S-A Linemen's Gloves, M-S-A Leather Protectors guarantee 100% fit. They shield against mechanical injury, reduce ozone cutting. 10-inch and 12¾-inch cuffs available.

**When gloves are not in use,** M-S-A® Canvas Glove Bags make ideal protective containers. Snap hooks and "D" ring enable linemen to attach bag to belt.

**Clip coupon below for more information.** Mine Safety Appliances Company, Pittsburgh 8, Pennsylvania. In Canada, Mine Safety Appliances Company of Canada, Limited, Toronto 4, Ontario.

Made to ASTM Spec. D-120, these curved finger rubber gloves increase wearer comfort and convenience without sacrificing safety or durability

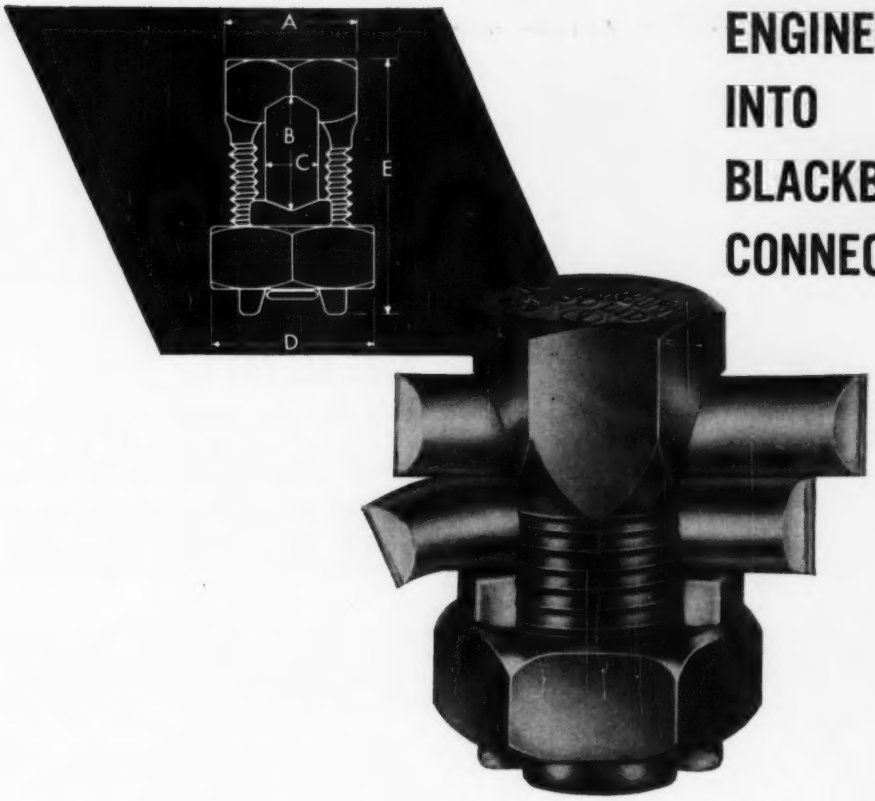
**Every day—in many ways—MSA products safeguard millions of lives**

MSA SAFETY EQUIPMENT HEADQUARTERS

**Mine Safety Appliances Company**
201 North Braddock Avenue
Pittsburgh 8, Pennsylvania

☐ Please send me new Linemen's Glove bulletin containing size, price and shipping info.
☐ Please have MSA Representative call.

Name_____
Title_____
Company_____
City_____ Zone____ State_____




# ENGINEERED INTO BLACKBURN CONNECTORS...

# REUSABILITY!

The big difference in Blackburn connectors starts with the way they are made. The basic material is high strength duronze, a silicon bronze alloy stronger than many structural steels.

High percentage of threads, both bolt and nut, plus proper selection of materials, reduces friction, increases thread efficiency and clamping force—clamping force is maintained on the conductors. Blackburn's strict inspection assures uniform high quality.

Blackburn connectors give better performance electrically. The greater thread efficiency provides a high clamping force that helps break through oxides on the conductor and improves conductivity. This high initial conductivity is maintained permanently.

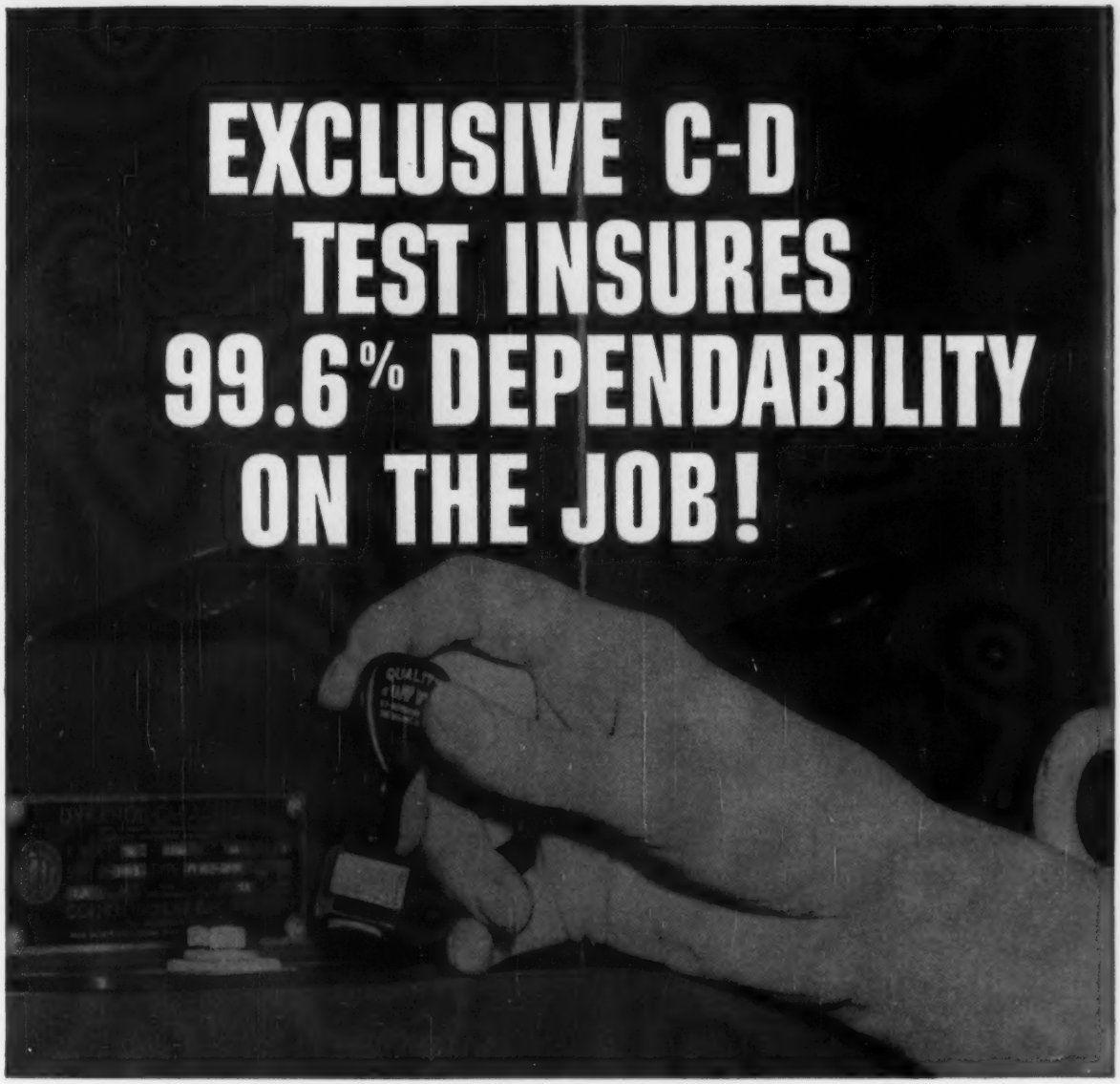
Because of the better materials, precision workmanship and careful inspection, Blackburn connectors are reusable . . . over and over. Write for samples.

LIVE BETTER ELECTRICALLY

Jasper
**BLACKBURN**
Corporation

1525 Woodson Road • St. Louis 14, Mo.

# EXCLUSIVE C-D TEST INSURES 99.6% DEPENDABILITY ON THE JOB!



## C-D CAPACITORS STAND UP WHEN THE HEAT'S ON.

Before Inspector #7 rubber-stamped his seal of approval on this 50 KVAR power-factor correction capacitor, it (as well as every shunt capacitor C-D makes) was subjected to capacitance, leak, dielectric and energization tests. The energization test—*exclusive* with C-D—puts the unit through an hours-long, full-voltage "heat run" that duplicates the same conditions the capacitor meets in the field.

Since most capacitor failures occur during the first few hours of operation under normal voltage, frequency, wave form and temperature conditions, you can be sure that if the unit passes the tests (and it *must* or we wouldn't ship it) it will have a long service life. Does it stand up? C-D capacitors deliver an unbeatable *99.6%-sure performance in the field.*

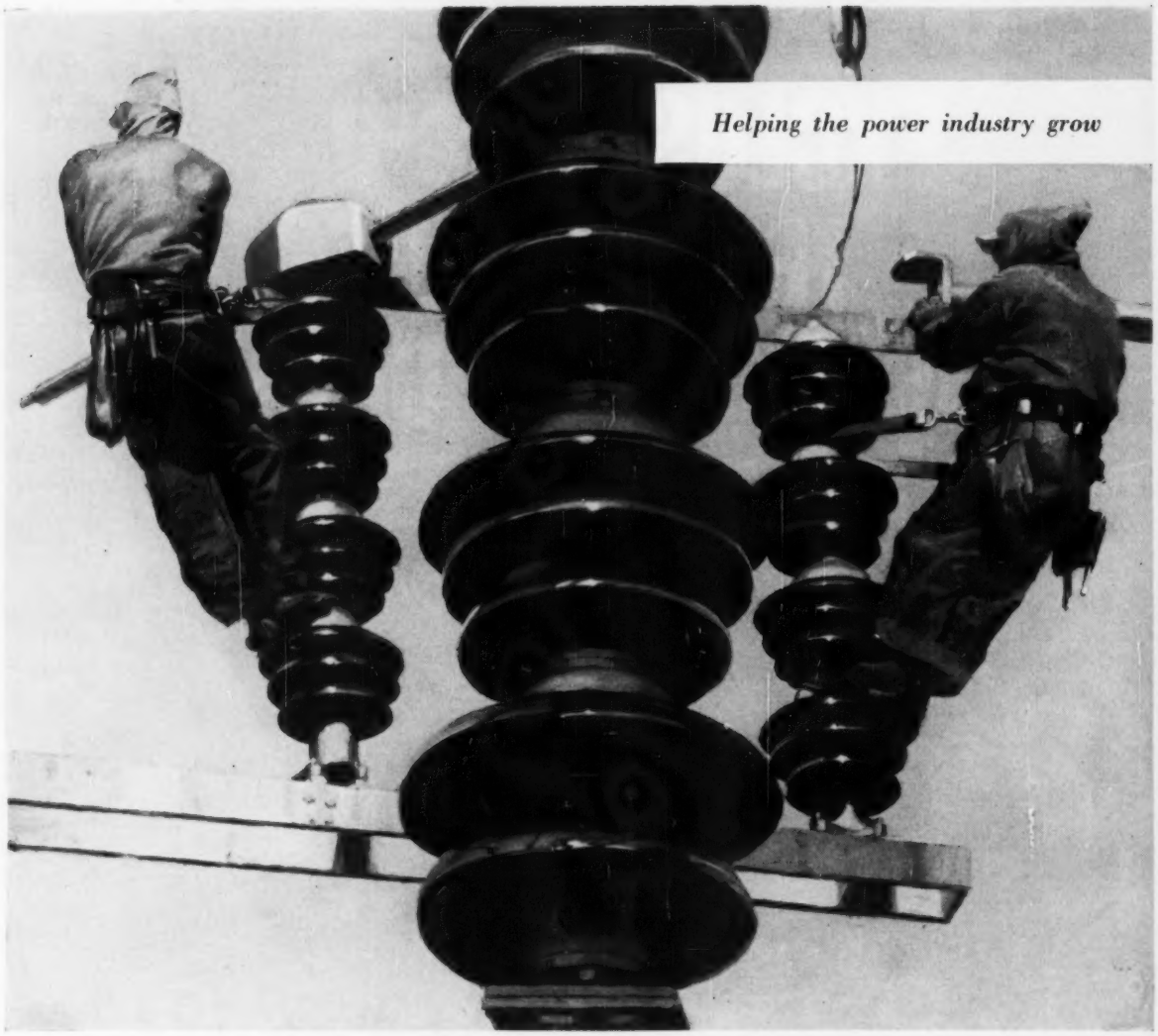
Invest your purchasing dollar in *internal* quality—the only place it really counts. See a C-D sales engineer today. Write to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

15, 25, 33.3, 50 and 100 KVAR capacitors for every application, with lowest dielectric unit stress, highest major insulation level and power losses considerably below the NEMA limit of 3.33 watts/KVAR.

*Consistently Dependable*

**CORNELL-DUBILIER**

**POWER-FACTOR CAPACITORS**




Skilled construction men and giant ceramic insulators in a high voltage substation harnessing the enormous power that serves homes and industries. Painting by Stanley Meltzoff.

# The Economy of Experience

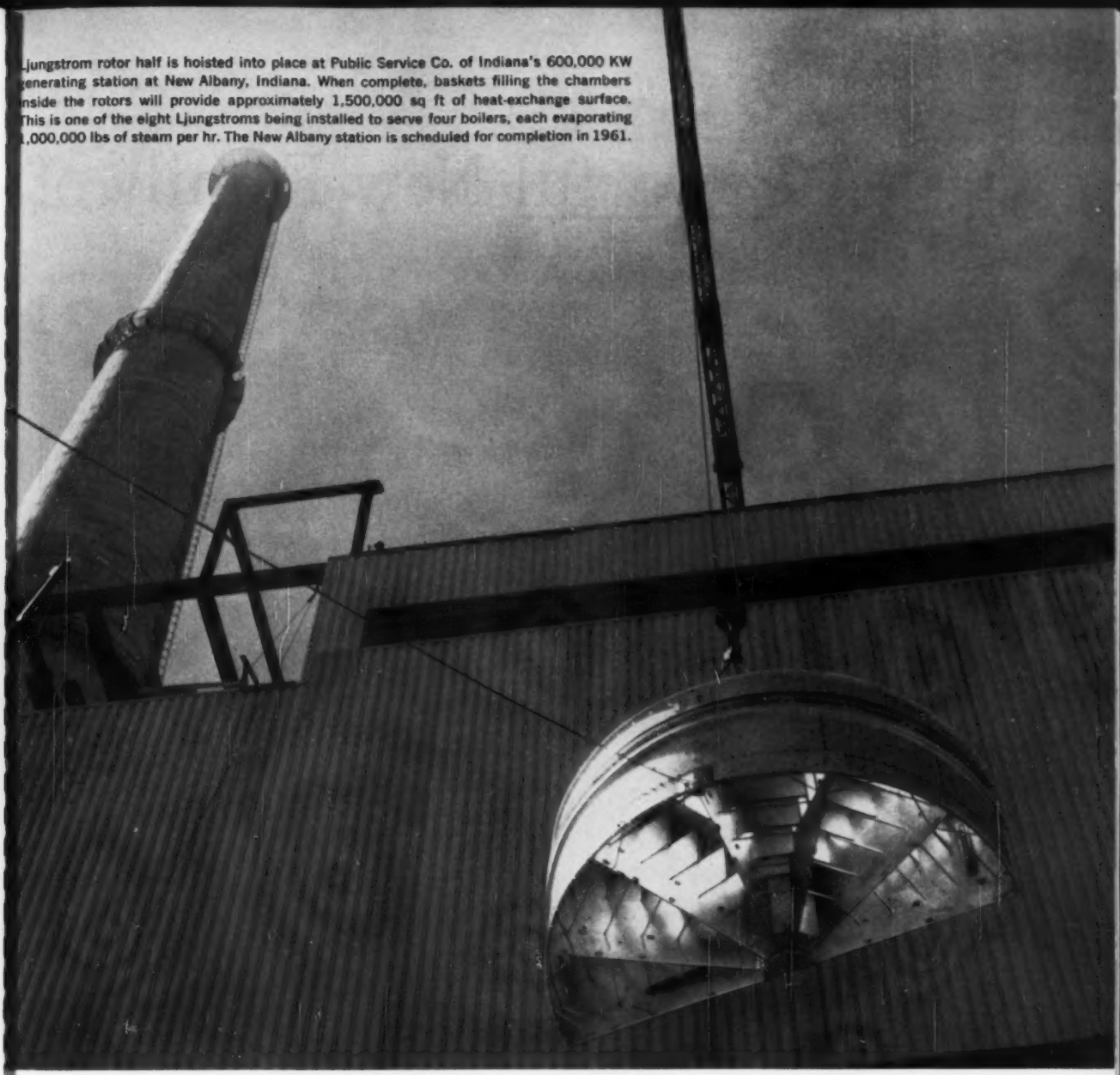
Operating within established budget limits in the design and construction of a power project, large or small, calls for experience of the highest order. Only this can effect cost and timesaving advantages — and still assure the smooth teamwork needed in design, purchasing, expediting and construction.

Making experience pay dividends to the client has been demonstrated on such projects as design and construction of hydroelectric and thermal plants and responsibility for installations that supply heating and process steam.

Let our skills and creativity augment the engineering facilities of your organization. Put to your service the advantages offered by United Engineers, with its background of 75 years' experience.

**UNITED ENGINEERS**

& Constructors Inc • U.E.&C. (Canada) Ltd. • New York • PHILADELPHIA • Chicago



Ljungstrom rotor half is hoisted into place at Public Service Co. of Indiana's 600,000 KW generating station at New Albany, Indiana. When complete, baskets filling the chambers inside the rotors will provide approximately 1,500,000 sq ft of heat-exchange surface. This is one of the eight Ljungstroms being installed to serve four boilers, each evaporating 1,000,000 lbs of steam per hr. The New Albany station is scheduled for completion in 1961.

# BEHIND NEW ALBANY'S **LJUNGSTROMS®** —**LIFETIME AIR PREHEATER SERVICE**

One of the major reasons why Public Service Co. of Indiana, Inc., chose Ljungstrom for its new generating station at New Albany is Lifetime Air Preheater Service.

Lifetime Air Preheater Service means that Ljungstrom engineers make regular calls *throughout the life of each unit.* They check to make sure your Ljungstroms are working at top efficiency, and that they'll continue to work that way. This service policy covers all Ljungstroms—right from the very first installation made in 1923.

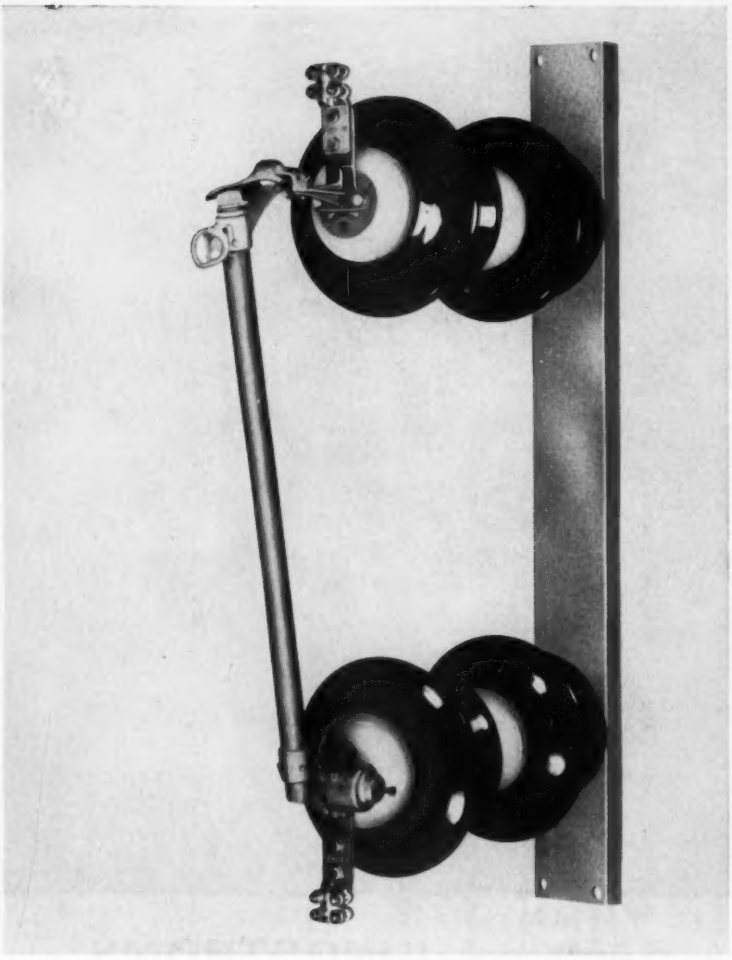
But that's not all. Air Preheater provides first-rate *emergency* service, too. For instance, a Ljungstrom customer in the southwestern U.S. recently called on a Wednesday night for replacement parts. Air Transport looked like the fastest way, but schedules indicated a minimum three-day delivery time. So Air Preheater loaded the parts on a pickup truck, and their men drove them more than 1,000 miles to their destination...34 hours straight driving. The parts were installed and in service by Friday morning.

Fast response to emergencies and regular inspection of Ljungstrom installations are two of the many advantages Air Preheater provides. Another is expert knowledge of boiler and preheater problems gained from over 35 years' experience. Perhaps these reasons explain why 9 out of 10 preheaters sold today are Ljungstroms.

## THE AIR PREHEATER CORPORATION

*60 East 42nd Street, New York 17, N. Y.*

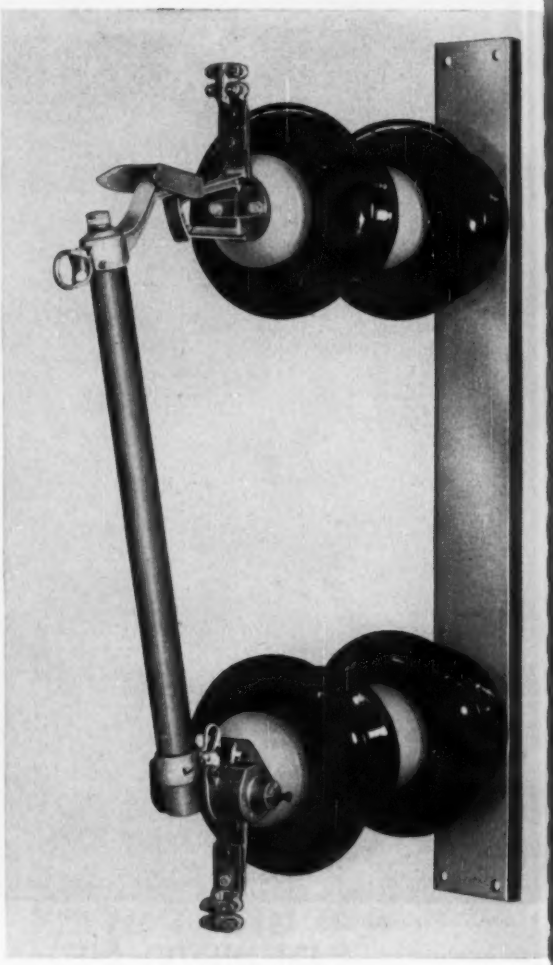
# A Powerful New Family of



## TYPE BP

**7.5 kv to 69 kv—100 and 200 amps**

This heavy duty power fuse is ideally suited for economical system protection when interrupting capacities range no higher than 1,491,000 kva.



## TYPE MP

**46 kv to 161 kv—100 and 200 amps**

This extra heavy duty power fuse is the huskiest of the Southern States line, with interrupting ratings as high as 3,480,000 kva. A real brute!

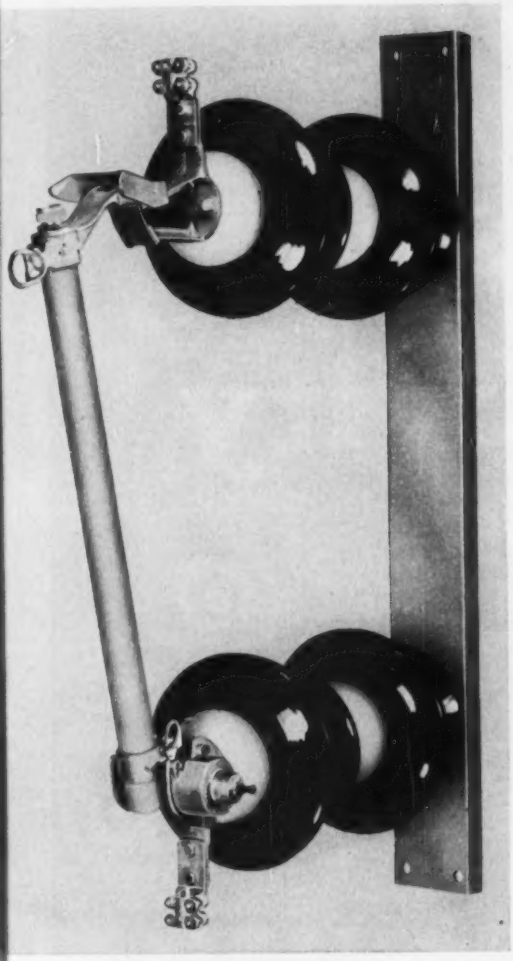
**PIONEERS IN POWER FUSES SINCE 1924**

**SOUTHERN STATES EQUIPMENT CORP.**

HAMPTON, GEORGIA

IN CANADA: Dominion Cutout Co., Ltd., Toronto

# Power Fuses by Southern States



## TYPE HP

**7.5 kv to 69 kv—300 and 400 amps**

This extra heavy duty fuse is especially suited for applications requiring a combination of high continuous current and interrupting ratings.

### COMPLETE FUSE KITS AVAILABLE

These economical kits, in clearly marked packages, provide field personnel with *all the components necessary* for quick, easy re-fusing. They are available in four speed ratios to meet all requirements. Contents are sealed in moisture-free polyethylene bags.

## • HIGHEST INTERRUPTING RATINGS

**Up to 785,000 kva at 23 kv—**
**2,350,000 at 69 kv—3,480,000 at 161 kv**

## • LOWEST INITIAL AND RE-FUSING COSTS

## • WIDEST RANGE OF SELECTIONS

Here is the greatest development in power fuses in years! It comes at a time when higher system faults and complex load conditions call for greater reliability in system protective devices.

Southern States Power Fuses can be used with full assurance of positive interruption in the complete range of fault currents—from the lowest that will melt the current-responsive element to the worst jolt the system can deliver!

The fuses employ a new fuse holder design and rugged fibreglass* fuse tubes to clear faults at values never before thought possible.

For example, look at these representative ratings:

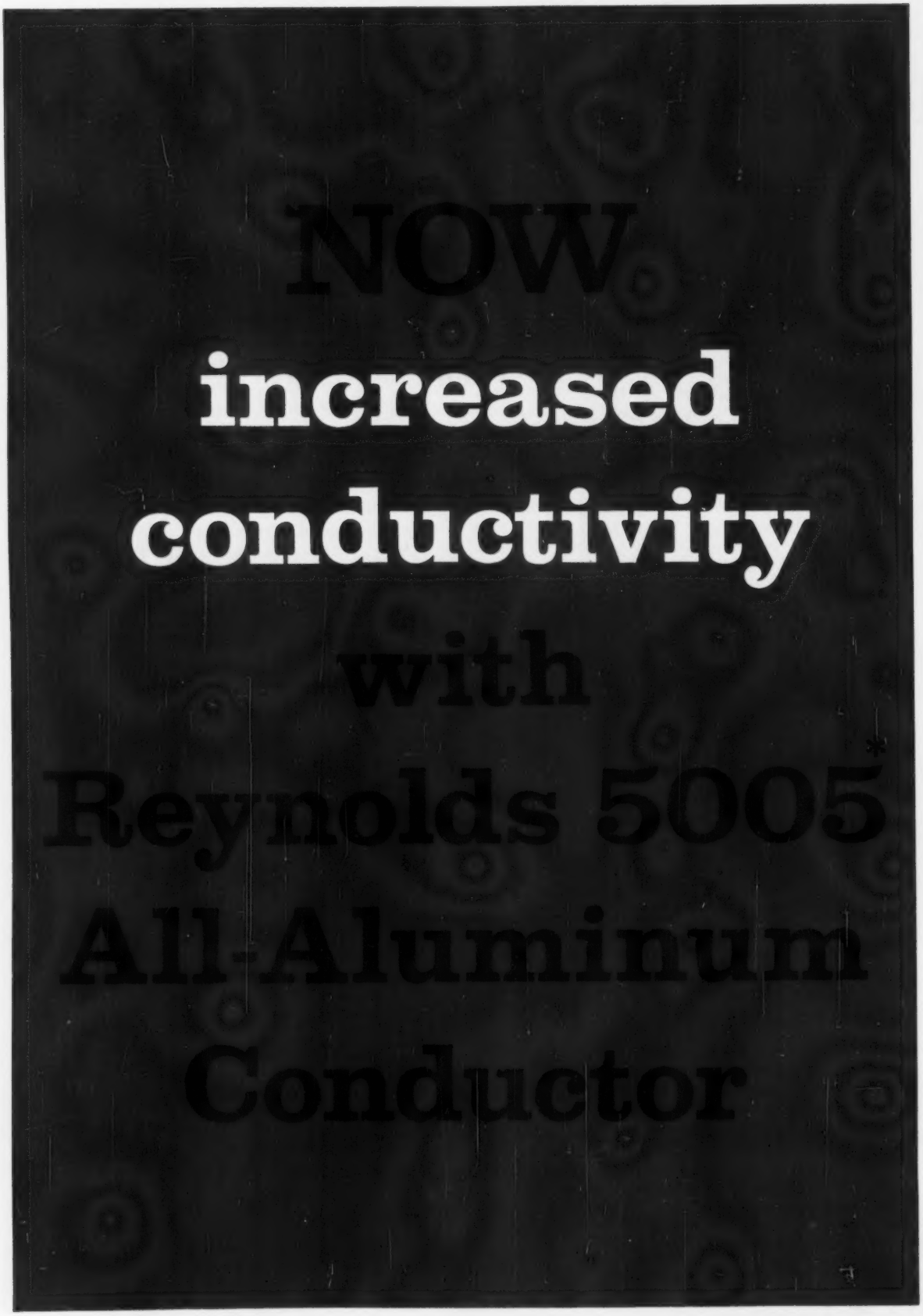
| TYPE | KV | KVA 3 phase symmetrical |
|---|---|---|
| BP | 7.5 | 162,000 |
| BP | 15 | 406,000 |
| BP | 23 | 785,000 |
| BP | 34.5 | 1,175,000 |
| MP | 46 | 1,988,000 |
| MP | 69 | 2,350,000 |
| MP | 115 | 3,110,000 |
| MP | 138 | 2,980,000 |
| MP | 161 | 3,480,000 |

Find out how these new Southern States Power Fuses can be used on your system—to provide greater protection at lower cost. See your Southern States representative, or

## WRITE FOR NEW TECHNICAL BULLETIN 59PF

**SOUTHERN STATES EQUIPMENT CORP.**
**HAMPTON, GEORGIA**

**For economy and where duty requirements are not excessively high, fuse tubes of NEMA grade XX bakelite are available below 46 kv at lower prices.*


NOW
increased
conductivity
with
Reynolds 5005*
All-Aluminum
Conductor

**You get more conductance at a lower cost than with any other standard conductor of comparable size and strength . . . lower power losses . . . improved voltage regulation . . . increased current carrying capacity**

Minimum guaranteed conductivity for Reynolds high strength 5005 All-Aluminum Conductor has been increased from 52.14% to 53.5%. This, along with the other outstanding advantages of 5005, makes it more important than ever that it be considered for your applications. These advantages are LOW COST . . . less than any other conductor with comparable properties. HIGH STRENGTH . . . 5005 is a high strength aluminum alloy and compares favorably in sag characteristics with copper and in many cases with ACSR. EASE OF INSTALLATION . . . no steel core means 5005 is lighter in weight, easier to install, easier to splice. There is no possibility of galvanic corrosion in contaminated atmospheres. BETTER SCRAP VALUE . . . if and when a line is scrapped, the all-aluminum 5005 will bring much higher value. PERFORMANCE PROVED . . . hundreds of miles of 5005 are in service . . . installation experience has been excellent and there have been no service problems.

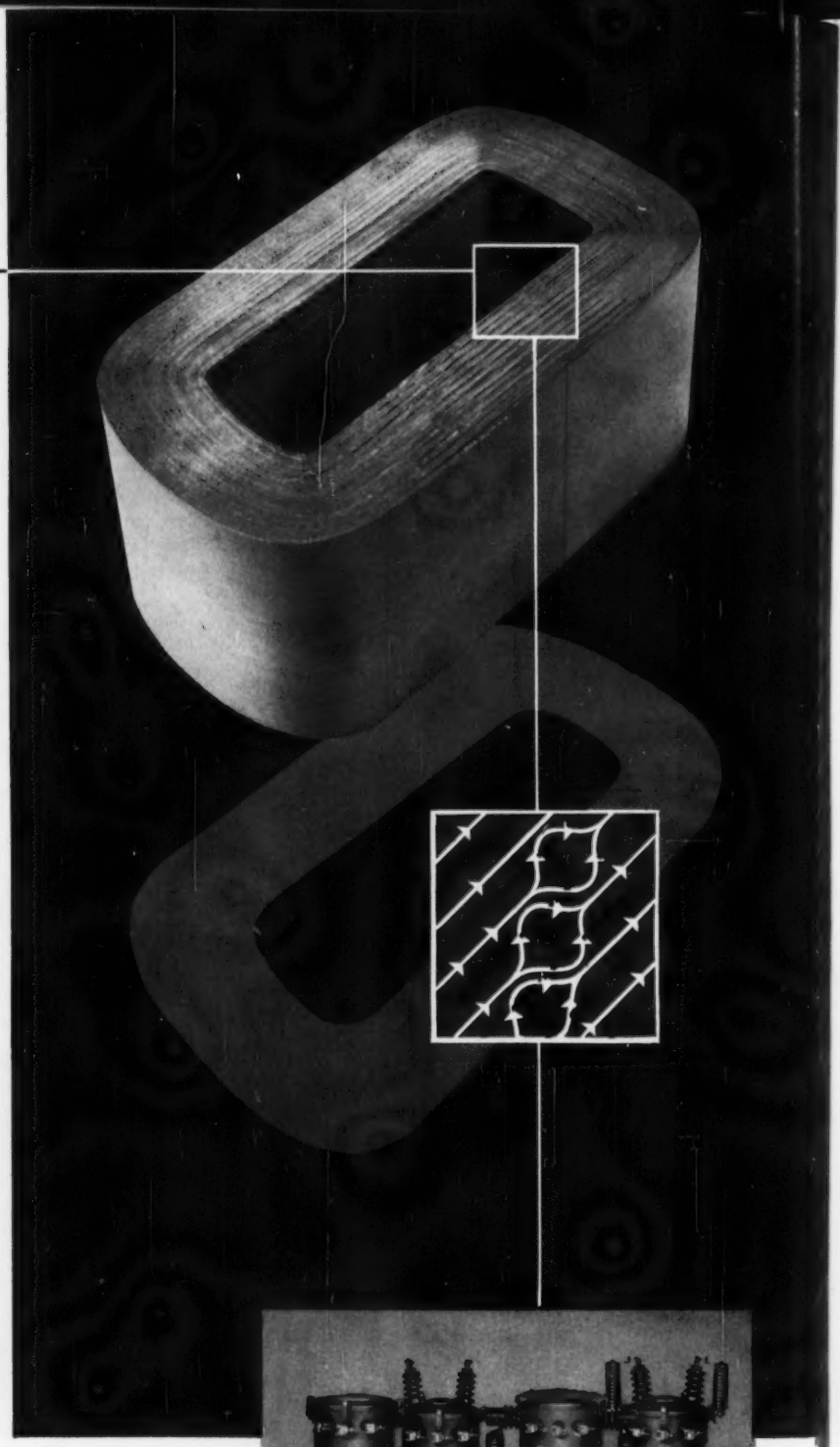
Investigate the advantages and economies of 5005 today. Complete data on Reynolds 5005 Aluminum Cable physical and electrical characteristics, sag and tension properties, is available from your local Reynolds branch office or your Reynolds Electrical Distributor. Or, write *Reynolds Metals Company, P. O. Box 2346-EL, Richmond 18, Virginia.*

** 5005 is a high strength all-aluminum alloy conductor developed by Reynolds. It compares with copper in sag . . . costs no more than ACSR. Write for brochure.*

# REYNOLDS ALUMINUM

Watch Reynolds TV show—"WALT DISNEY PRESENTS"—every week on ABC-TV

## THE MOLONEY CORE . . . DESIGNED FOR PERFORMANCE



Developed by Moloney engineers for use in distribution transformers, the MOLONEY CORE is made of single-turn, cold-rolled, grain-oriented, silicon steel laminations having the ends butted one against the other. To accomplish a high permeability path for the magnetic lines of force and reduce flux density at the gaps, the butt joints are distributed over one entire side of the core and arranged so that adjacent laminations do not have air gaps opposite each other. After the core is formed, it undergoes an annealing process to relieve any mechanical stresses introduced during manufacture.

The MOLONEY CORE is a compact core having low losses and exciting current, thereby keeping operational costs to a minimum, and is the result of research and development programs dedicated to the continued improvement of Moloney Transformers . . . Specify Moloney Transformers . . . All Along the Line.

MEDD-2

**MOLONEY ELECTRIC COMPANY**

*Manufacturers of Transformers for Utilities, Industry, and Electronic Applicatio*

**FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA**

# Editorial Comment

AUGUST 10, 1959

## Close Look at Costs Can Reshape Industrial Systems

The last few years have witnessed a steady and commendable improvement in industrial electrical systems. Electrical World's survey of industrial distribution practice, beginning on page 65 of this issue, reveals that many manufacturing companies are becoming more and more aware of the importance of the plant distribution system as a vital production tool.

This is very encouraging. In fact, it is downright essential, if industrial distribution systems are to keep pace with surging industrial loads and, more important, the stringent service conditions that automation is imposing.

However, the survey also indicates that many industrial companies are still trying to serve 1959 loads with a Model T distribution voltage. Often the men who control the purse strings do not fully realize the hidden costs that inevitably accompany the use of too low a distribution voltage.

Most industrial companies keep good records of the cost of obtaining power. Few know how much mileage they get out of it. Frequently a thorough study of the dollars and cents significance of power losses, production stoppages, and poor machine efficiencies will convince an otherwise reluctant management of the need for distribution system improvements.

The industrial electrical engineer is the key man in the picture. As part of his power system responsibility, he must assume the burden of keeping his management aware of the true cost of an inadequate distribution system.

## Tailored Synthetics and the EHV Dielectric Dilemma

Cable manufacturers are generally agreed on the need for research in the area of extra high voltage cable dielectrics. Dielectric loss and charging reactive power requirements of foreseeable EHV cable designs, like those soon to be tested at Cornell University, impose specific limitations on permissible continuous lengths. Today the limitations of paper insulation for EHV cable are much better defined than the characteristics and potentialities of the synthetics that may someday displace it.

However, the picture is changing rapidly, and it is difficult to say when or from what branch of science the crucial breakthrough may come. At the 1958 CIGRE conference it became evident that cable makers of the world had done a great deal of research on synthetic insulations for EHV and had developed cable designs specific to their use. But the top choices among synthetics all had insuperable shortcomings. What the cable makers were groping for was a synthetic material tailored specifically for EHV cables.

In a discussion of cable dielectrics at the recent AIEE meeting, cable engineer Kenneth S. Wyatt observed significantly that up to now the chemical industry has come upon new synthetics accidentally and then tried to find new uses, modifying them somewhat for each field of application. The time is approaching, Wyatt said, when available knowledge will be utilized to tailor a molecule to the exact requirements of the extra high voltage industry.

Polymer chemistry has today reached an advanced stage of understanding and so has our knowledge of what causes deterioration of insulation at EHV. This makes it certain that somewhere in the world and in the foreseeable future a synthetic resin with the molecule tailored specifically for EHV will be produced.

The resulting synthetic may well resolve today's dielectric dilemma.

# Detroit Edison's Belt Tightening

**Practices company used during recession helped shave costs when loads and revenues dipped. Many have been continued**

While the spectre of the 1957-58 recession has happily passed into history for most people, the cost-cutting, belt-tightening lessons it taught many utilities have not been forgotten. And if the current nationwide steel strike drags out for a long time, some of those lessons may have to be put to use again.

The recession experiences of the Detroit Edison Co in cutting costs to meet dropping load and revenues are as comprehensive as any. Some of the actions Detroit Ed took during the recession paid off handsomely for the company, and may well be of value to other utilities.

Southeastern Michigan—the area Detroit Ed serves—is probably the most sensitive economic barometer in the country. Its health is closely tied to the automobile industry, and when auto sales are poor, whole neighborhoods see spending dwindle to only the necessities of life. Unemployment in Detroit alone reaches 280,000 during these periods.

### Recession Forecast

The shutdown plants, the slower retail buying and household consumption shows up on Detroit Ed's load tables long before the rest of industrial America is aware that trouble is brewing. Says Deco Vice President Arthur Griswold: "We could see a recession ahead early in 1957, but we had no indication of how serious it would get."

**DETROIT ED'S SCOTT:** 'Better to just mosey along'

The seriousness, of course, is a matter of record. The utility's gross revenues in 1958 declined for the first time since 1944. Industrial kwhr sales fell off 10%, and residential usage fell well below its normal growth rate.

What did Detroit Edison do?

The company's first and most important action was to trim new starts from its construction budget. "We were prepared to continue at a $90-million annual rate, but when the economy faltered we retracted to keep our total system in line with the power load," Griswold notes. Capital outlay for new facilities fell to $78 million in 1957, $72 million in 1958, and $65 million this year.

### Construction Cuts Remain

Vice President and Controller Eldred Scott expects expenditures to remain at the latter figure for a while. Economies were affected by a strict ban on construction overtime, no new major programs and a careful watch on minor building. Much of the minor construction was contracted to hold down payroll.

"Moseying along," as Scott calls it, is cheaper than shutting down a project, but it resulted in No. 5 unit at St. Clair being 4 months late in coming on the line and No. 6 will be off-schedule by a year. The Enrico Fermi A-plant was not affected.

Even after several years at the reduced pace, the company has a 30% gross margin of generating capacity. This is higher than the 1958 national average of 25%, and Griswold would like to see it shaved to 15%.

Deco executives interviewed by EW emphasized that outside of construction cuts, cost-cutting actions taken could just as fairly be attributed to careful management as to the recession. True, the economy word went out to each department and was pointedly underlined by a letter from Pres Walker Cisler to each employee on May 15, 1958, but no action was taken that would undermine employee morale or in any way impair service to customers.

Scott noted two items as typical of moves that could be attributed as much to good management as to the recession. Deco formerly considered a 50-day coal inventory as minimum, but this has now been cut by 5% with no appreciable change in safety factor. Another was increasing the number of unattended sub-stations by automating them.

### Very Few Laid Off

There were few layoffs. Employment dropped by 900 persons from July, 1957 to its present total of about 10,300, but the cut was accomplished almost entirely by attrition. Every employment requisition, whether for a newly created job or for replacement, is still personally scanned by Controller Scott.

Overtime within the organization was cut from 2.2 million payroll hours in 1956 to 1.3 million in 1958. Based on the current average wage of $3 per hour, this represents a direct annual saving of $2.7 million, and was accomplished despite an overall rise in output and 900 fewer employees. There have been no wage or salary freezes.

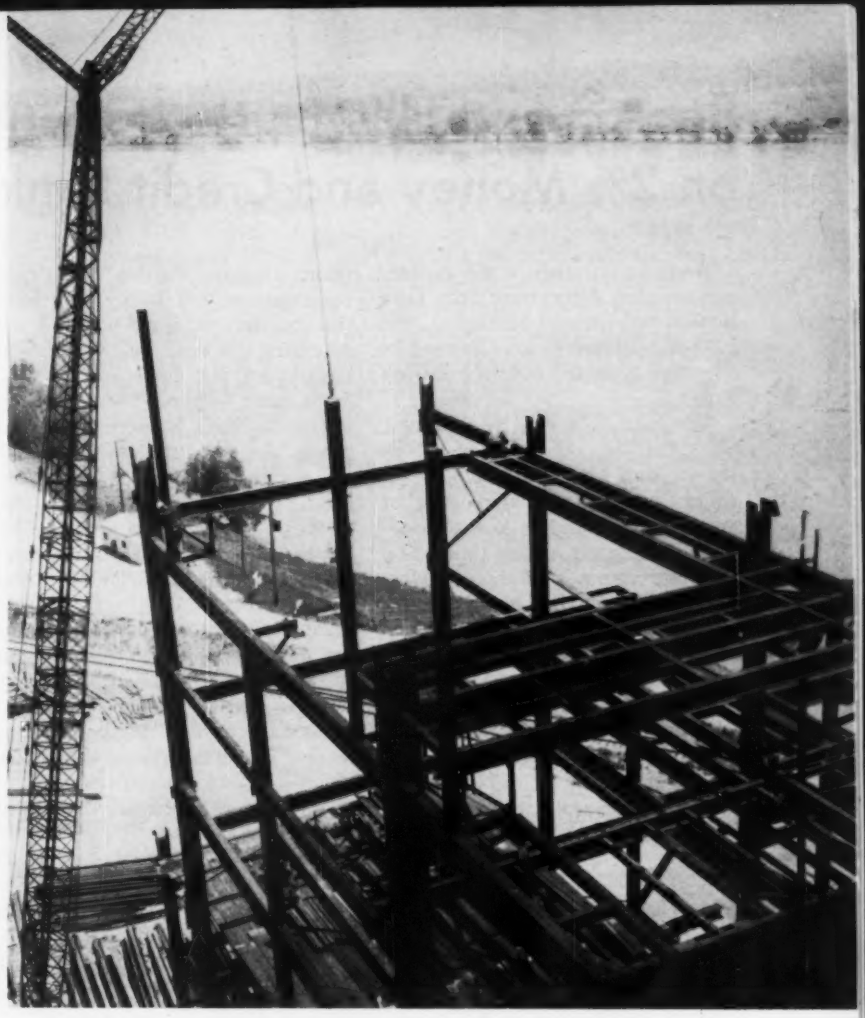
Installation of computer equipment was actually stepped up due to the recession, as part of a program to widen the application of electronics within the company. Customer billing with an IBM 707 is in operation. By 1960, the budget provides for practically all accounting and some routine engineering to be done electronically.

### Fixed Expenses 'Spread Out'

A program to "spread out" fixed expenses, particularly in the maintenance area, was inaugurated and worked so well that it is being continued. Example: The abandonment of regular inspection schedules on old turbines. They are now inspected only to see that they will produce power, without too much attention paid to efficiency. Intensive maintenance on old machines has been replaced by the casual or necessitated. There has been no change in maintenance schedules for newer, lower-cost generation.

Other maintenance programs, such as tree trimming, also have been cut back. Building maintenance is now dictated by necessity and not

# Paid Off



beauty. Opening of Deco's new central parts warehouse in a renovated automobile factory has permitted a substantial inventory reduction.

Many cost-cutting ideas were generated by Deco's unique "objective" program. In this, supervisors periodically submit to management the detailed aims or goals of their departments. Controller Scott happily notes that of the 537 submitted in 1958, a record 278 were directly related to cost reduction.

This record is partly the result of an indoctrination program inaugurated as a recession measure to instill cost-consciousness in supervisors who would, in turn, pass it on to subordinates.

**Increase Revenues, Too**

In Scott's mind, cost-cutting during a recession should not overshadow attempts to increase revenues.

Recent Deco successes include a new promotional rate for water heaters. The idea was to give customers more hot water at a lower rate, but the deal included changing (by permission only) the charging period from 10 to 20 hours, thus giving Deco more load.

The company launched intensive water heater and drier campaigns, despite the handicap of having abandoned the practice of free installation. An intensive house-to-house selling campaign helped boost total 1958 water heater sales to 18,143 units.

No thought was given at any time to restricting or eliminating Deco's nationally famous free light bulb and appliance repair program, despite the fact that it costs the company 60¢ per month per customer.

No consideration was given to requesting a rate increase. [The company has not had one since 1949.] Instead a new, lower rate was inaugurated for high-use residential customers.

Late in 1957, a system development department was created under Harvey Wagner. All future planning is now under close control.

Deco has strengthened its power sales division, which advises industries on new usages. Its 12 engineers have their eyes on Ford's Rouge plant and a Dodge's assembly facility, which are the only major users left in the Detroit area that produce their own power.

Four personable, civic-minded development engineers under Wilbur Young, have turned in an impressive performance in helping communities within Deco's 7600-square mile service area prepare for and get new industry.

Recent examples are a 150-man plant for Evans Products in Gagetown, and a 100-man facility for Howell Industries in Howell. Using National Chamber of Commerce figures, the latter will mean for Howell: $590,000 more personal income, $270,000 more in bank deposits, $360,000 more retail sales per year, 107 more passenger cars registered, and four more retail establishments. These and the 296 people that make up the workers' families are all customers.

These communities are some of the 25 who have organized a new industry committee under the guidance of Deco's group. The requirements for this select group of communities are stiff. Land must be set aside and controlled, and reserved for industrial use; a committee of responsible citizens to deal with industry must be established; and the community must be working on or have a master growth plan.

Detroit Ed backs the chosen areas with attractive and free brochures outlining their advantages, an area development movie that recently won a Chris award, and national advertising campaigns. As one of their engineers put it, "We're just trying to make jobs, so that these newcomers will become our customers."

In this he is certainly backed by President Cisler, who is known as Michigan's first ambassador. His long hours spent as chairman of Detroit Tomorrow Committee, Economic Club of Detroit, and Greater Michigan, Inc, tend to prove it.

# Benson and Ellis Battle It Out on 2% Money and Credit Bank

BENSON

ELLIS

Another skirmish in the running war between Agriculture Secy Ezra Benson and General Manager Clyde Ellis of National Rural Electric Cooperative Association broke out last month.

The battlefield was in Roanoke, Va., and the occasion on which Benson and Ellis exchanged verbal volleys was the annual meeting of the Virginia Assn of Electric Cooperatives. Benson, a long-time co-op booster, recommended that: (1) electric co-ops pay the going interest rate on loans, as opposed to the present 2%; and that they set up a co-op-owned credit bank to handle future financing.

Said Benson: "Two percent does not cover the present costs of money to the government. The 2% interest rate should be replaced by a rate on new loans which will cover the current cost to the Treasury . . ."

Benson then went on to propose a credit bank for electric co-ops similar to those set up under the Farm Credit Administration to meet other farm credit needs. "I have proposed the development of a similar permanent financing plan to provide the necessary future credit for rural electric and telephone systems. In this way you could have your own National REA Credit Board to help operate the bank in the best interests of the rural electric and telephone systems. Farmer owned and operated lending institutions have worked well in other fields. I am sure they will work well in the rural electric and telephone field."

"It can't be done!" was Ellis' rejoinder to Ezra Benson's two proposals, and he went on to summarize the reasons why co-ops must continue to have 2% money: (1) An increasing number of co-ops are failing to make debt service, the number reaching 166 in 1958; (2) Rural systems have built up only a 16% equity in 24 years' operations, there are over 400,000 idle connections (which cost $500-million) on co-op systems, and they can't serve urban territories (over 1,500 population) where "cost-plus" power companies operate; (3) Most co-ops don't have their own power sources "and have to depend upon generally unfriendly sources at high costs"; (4) Co-ops are committed to area coverage, including consumers who don't pay their own way; (5) "The co-op service areas in most states are subject to rather constant raiding of their larger users by the cost-plus power companies. This is a one-way street. We can't raid them even if we wanted to, which I am sure we do not"; (6) Co-ops can't serve anyone already receiving power, "even though the rural electric systems could do it better."

Ellis, of course, has said all this before. Of particular interest this time is his reason No. 6. This may be part of his continuing campaign to bring the co-ops out of the "skim milk" areas into the heavier populated "rich cream" ones.

# Congress May Probe Co-ops on Service to Large Towns

A possible Congressional investigation into the justification for several rural electric co-operatives serving in towns in excess of 1,500 population came to light last week.

Chairman Carl Hayden (D-Ariz.) of the Senate Appropriations Committee earlier this year had questioned REA Administrator David Hamil on complaints that co-ops had illegally been permitted to serve customers inside towns of 1,500 population — specifically forbidden by the REA Act of 1936.

Hamil's response to Hayden, just released, cites 295 cases where co-ops are serving subscribers within towns of 1,500 population, but only seven of these are listed by Hamil as possibly unjustified. In most cases, the towns grew to exceed the population barrier after the service began. His breakdown:

- There are 103 co-ops presently serving 30,279 customers in 143 towns over 1,500 population—In every instance the co-op lines were taken into the town limits through boundary extensions after service began.
- There are 55 co-ops serving 52,018 customers in 74 towns over 1,500 population—in each instance the town grew past the population restriction after service began.
- There are 54 co-ops serving 50,599 customers in 78 towns which were over 1,500 population when they entered (60 supply retail, 18 supply wholesale service). REA considers all but seven of these, serving 83 retail customers, justified.

# British Give A-Power Report Cool Reception

The fifth annual report of the United Kingdom Atomic Energy Authority was presented on July 23 under the slight shadow of economic coolness towards atomic power, both among utilities and manufacturers. As reported previously (EW, June 29, p 40) the 'precipitate' fall in the cost per kilowatt of British coal-fired power plants, together with enhanced thermal efficiency, has put back the break-even date from 1965 to about 1970.

### Orders Cause Anxiety

The small number of orders for atomic power plants, both at home and overseas, has caused anxiety on the manufacturing side as to when the vast research and development costs will be recovered. For these reasons, the progress of the Atomic Energy Authority on prototypes for future, cheaper stations was of special interest.

Immediate further development of the civilian reactor program is contemplated involving two reactors, now under construction at Windscale. Both are of the graphite moderated carbon dioxide cooled type, at present standard in the UK. The Advanced Gas Cooled Reactor (AGR), of 100 MW heat rating, will use slightly enriched uranium dioxide in a ceramic compound, with beryllium cladding. The smaller HERO reactor, also at Windscale, will have zero power output and will serve for detailed studies on aspects of the AGR design.

### Higher Design Conditions Sought

Higher core temperatures than presently attainable, higher neutron flux and increased coolant pressure together with better heat transfer are the aims of the AGR and HERO team, so that the next generation of gas-cooled reactors for the Central Electricity Generating Board's program (for installation in about 1965-66) will have lowered capital cost and improved efficiencies.

Other major reactor experiments described in the report relate to gas-cooled, heavy-water-moderated types, and steam-cooled types with the same moderator.

• The boiling water reactor is not considered economic in the UK, owing to the cost of the necessary enrichment of the uranium fuel.

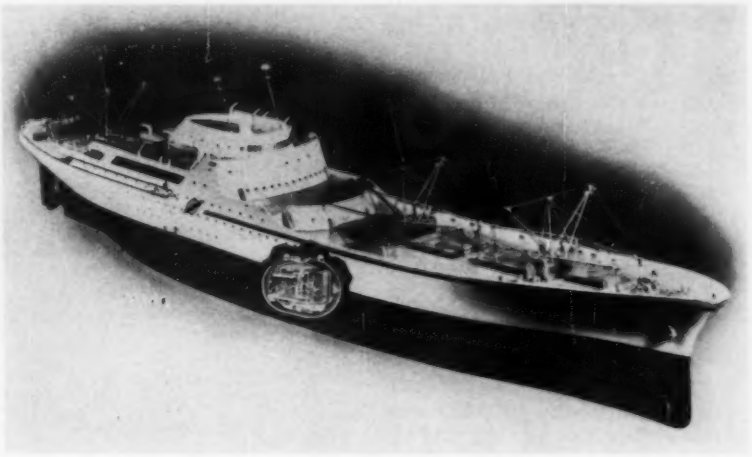
• A high temperature gas-cooled reactor, using graphite as both moderator and container for the fuel, is under construction at the new Winfrith Heath establishment, for European Nuclear Energy Authority.

• The fast reactor at Dounreay, Scotland, of 60 MW heat output, using sodium-potassium alloy as the coolant and enriched uranium or plutonium as fuel, is due for criticality in the next few weeks.

Principal surprise in the press conference associated with the presentation of the report was the announcement concerning ICSE, the new device for research into thermonuclear fusion. Initials mean Intermediate Current Stability Experiment.

ZETA, the British thermonuclear research device, was found to have yielded valuable results, but the causes of loss and instability in the plasma could not be evaluated with sufficient accuracy. The new ICSE machine (like ZETA) is of the torus type, "a larger ZETA, slowed down." The capacitor-fed energy input will be of the order of five to ten million joules, but this will be released in microseconds instead of milliseconds, as at present with most British, US, and USSR thermonuclear devices. The plasma should be stable, and its behavior should be easier to evaluate.

It was claimed that ICSE will make a most valuable contribution to thermonuclear study; but no one would predict the date of the first commercial fusion station.



# Savannah May Aid Atom and Steam Plants

The N. S. Savannah, the world's first atomic-powered merchant ship, is expected to advance the art of both mainland and marine nuclear plants, according to spokesmen for firms that built her. She may also bring about an important modification of conventional steam turbine generators.

The pressurized water reactor, above, built by Babcock & Wilcox Co for a cost of $10.3 million, is moderated and cooled by light water at 1,750 psia. Fuel is $UO_2$ enriched by about 4.4% $U^{235}$ clad in stainless steel rods. Design target was 52,000 Mw days, or 1,230 days at average operating power, which normally will be 63.5 Mw.

The core has 32 fuel elements, each consisting of 164 fuel rods. As for containment, some 1,060 tons of concrete, 481 tons of lead, 68 tons of polyethylene and 136 tons of steel in the collision mat are used. Shielding will permit limited access for maintenance only 30 min after shut down.

## TVA Bill in Muddle

A desperate, 11th-hour drive to salvage some sort of TVA bond bill —awaiting final action last week at the White House—set off a very curious chain of events in Washington, as Electrical World went to press.

The bill's backers claimed an agreement had been reached for the President to sign the TVA bill (HR-3460) on assurance that a second measure would be voted out soon after by Congress to eliminate features in the original bill disliked by Eisenhower.

Not so, claimed other officials. Any "deal" depended on the President being able to sign both bills simultaneously.

Word got out last week that the President definitely planned to veto HR-3460 as it stood, so the bill's backers—at the suggestion of the TVA directors who also met last week at the White House—quickly introduced a second bill (S-2471) in the Senate to eliminate two controversial provisions in the earlier bill.

## TVA Sales Hit New Peak

Tennessee Valley Authority sold 57.2 billion kwhr of energy during the fiscal year ended June 30, outstripping last year by some half-billion kwhr. Sales to AEC were down slightly.

TVA's revenues also hit a new peak, of $236 million, topping last year by $4 million.

Another 775,000 kw of capacity was added during the year—all in steam plants. Three-fourths of the Authority's 11 million kw capacity is now in steam.

## Life Saver Retires

Edmund W. Oesterreich, originator of the pole top method of respiration that bears his name, retired July 1. On the occasion the Accident Prevention Committee of Edison Electric Institute wrote the Duquesne Light Co employee a letter acknowledging his contributions to safety. ". . . Your technique has played a major role in the saving of over 200 lives. For your contributions to the savings of human life, you have earned the thanks, commendation, and honor of our great industry and the nation at large."

One month before, quick-thinking Edward Metesser of Duquesne Light used the method to revive a co-worker. It was the first time in seven years that a Duquesne lineman had to resort to the method.

## More Power for Italy

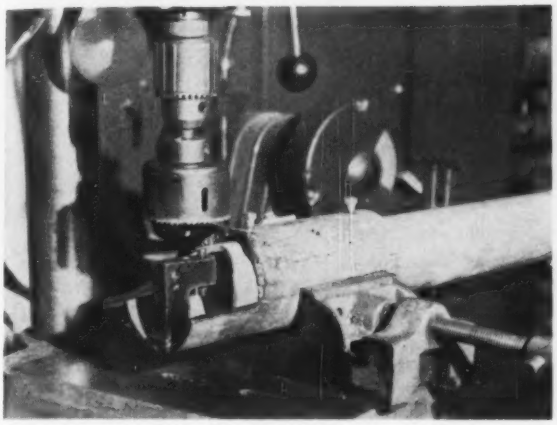
Milan (*McGraw-Hill World News*) —One large hydro plant near Rome and two in northern Italy recently went into operation. Between them, they will furnish the country with about ¾ billion kwhr per year.

The Quart and Avise plants, in the north, are fed from a 433-ft dam built more than a mile above sea level.

The San Angelo plant, near Rome, is the first of three hydro stations being built as one project. The other two will be ready in 1961.

## Ferry HQ Will Cut Construction Costs

After 47 years of commuter service, the S. S. Niagara, a 208 ft long ferry, has been purchased by Public Service Electric & Gas Co to serve as a storeroom and office for plant construction projects. The boat cost less than $25,000 and will mean a savings of some $6 per sq ft over the expense of a conventional building, which would have to be dismantled and moved to the next construction job. Alterations now are under way on the craft to convert the 18,000 sq ft of usable floor space. The lower deck passenger area will become clerical offices and two auto lanes will become a general shop section after a center well is removed. The ship's engines and boilers have been scrapped, the company reports, and no changes in the steel hull will be necessary. First use of the craft will be in the Arthur Kill River near the Sewaren Generating Station where a new 342-Mw turbine generator is being built by United Engineers & Constructors, Inc.



**JOINTS ARE CUT** in tubular aluminum using a special jig and a hole saw. End of aluminum tube is prepared for a 90-deg joint in about 5 min, as against 45 min formerly

# Simplify Cutting of Aluminum Bus

**ROBERT T. MATSON,** Line Supervisor, Kansas Gas & Electric Co, Wichita, Kansas

Cutting and fitting of tubular aluminum substation bus for 90-deg taps has been greatly simplified for Kansas Gas & Electric Co by the use of a specially developed jig and a hole saw. The job must be done so that joints can be welded in the field.

The jig has two cut marks on its back that are 180 deg apart. The section of tubing to be cut is clamped against a stop in the jig and a pencil mark is made on the tubing at one of the cut marks. After the cut is made on one side with the hole saw, the tubing is rotated until the pencil mark coincides with the opposite cut mark on the jig. The cut is then made on the other side. The job takes just 5 min. The jig was developed by substation foreman R. F. Jennings.

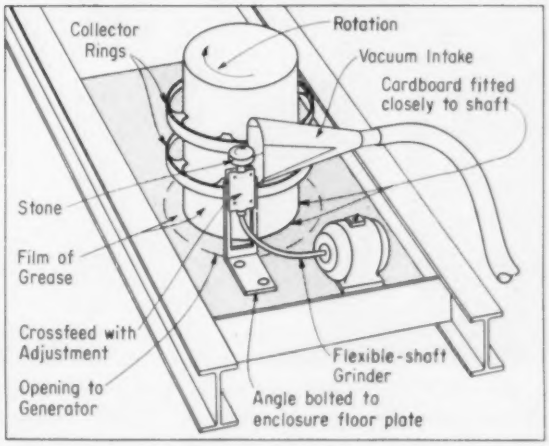
In the past V-cuts for joints were made with a hack saw and ground with a stone. Time required was 45 min.

# Protect Generator During Grinding of Rings

**R. W. SPEAS,** Hydro Plant Supervisor, Kanawha Valley Power Co, Charleston, W. Va.

A simple scheme enables Kanawha Valley Power Co to grind collector rings on vertical hydro generators while protecting bearings and windings from abrasive particles. Grinding of rings in place with the shaft turning at rated speed saves about 32 man-hr per generator each time rings are ground.

A temporary shaft seal of cardboard, cut with a gasket cutter, is taped firmly and snugly around the generator shaft. An industrial-type vacuum cleaner fitted with a large intake funnel removes grinding dust. The cardboard seal is greased so that loose dust particles will cling to its surface. The same protection and vacuum funnel also remove carbon particles created as new brushes are seated.



# Cites Compensation Law Change

## Speaker tells EEI safety group AFL-CIO wants A-plant protection federalized, limit on third-party injury suits

Federalization of workmen's compensation laws for nuclear plants, as promoted by the AFL-CIO, could radically change the basis of settling accident suits, the Edison Electric Institute's Accident Prevention Committee was told at its recent annual meeting in Los Angeles.

California Assembly Bill No. 1015, now pending, excludes third-party suits in injury cases except those involving violation of statutes, intoxication, wilful negligence, and negligence contributing to the injury, said R. W. White, Pacific Gas & Electric Co. The bill, he explained, would eliminate the problem arising when other employees of the company are sued because workmen's compensation laws prohibit suing company officials.

William Leone, Consolidated Edison Co of New York, reported to the meeting that the Atomic Plant Safety Subcommittee and the Atomic Plant Safety Task Force have agreed tentatively on the need for:

**1.** Uniformity of personnel monitoring.

**2.** A method of reporting overexposure.

**3.** A method of measuring total exposure within atomic plants as a comparative index.

**4.** Radiation work permits.

Mental and emotion factors may be responsible for as much as 75% of the fatal and near-fatal accidents to utility company personnel engaged in dangerous work, James F. Davenport, vice president, Southern California Edison Co, said in the opening speech.

Proof of the role of these factors in serious accidents would give the utilities a lead in a field now overlooked, he said. His views were supported by another vice president of the same company.

"I believe that there is some correlation between human relationships in the working environment and the accident-frequency rate," said W. E. Montgomery. "In groups where morale is high, concern for the welfare of each other may well extend to protecting each other from hazards."

The death rate due to electric shock is actually twice to four times as high as the traffic death rate, said I. R. Dohr, Consumers Power Co. Although 1958 statistics show a remarkable decline of fatal accidents in the industry, electric shock continues to account for 75% of all fatalities, he said.

Reports from 88 companies show 86 fatal accidents during 1958, said S. H. Young, Hartford Electric Light Co. This number, he noted, should be compared with the 132 per year average of the 1949-58 period.

Erroll Dunbar, Potomac Electric Power Co, put the 1958 total of electric shock and burn injuries, including fatalities, at 425. There were three flash and 62 contact deaths.

Of the 199 non-fatal flash burns, 28 were lost-time injuries with an average loss of 98 man-days, Dunbar noted, and 161 non-fatal contacts resulted in 57 lost-time injuries and 456 average man-days lost per contact injury. He noted that 30 lives were saved last year over those in the previous year.

Severity records have improved tremendously, Dunbar said, yet an average of more than a year lost time per injury remains an important consideration for utilities budgeting money for extra personnel protective equipment. Almost all contacts, he said, could have been prevented by making sure protective equipment was furnished and used.

Improper training or field super-

*(Continued on page 124)*

**ARTHUR NAQUIN,** New Orleans Public Service (left) is chairman of EEI Accident Prevention Committee, succeeding I. R. Dohr, Consumers Power (right)

# Table Lists Inductive Reactance of ACSR Bundled Conductors at 60 Cyles†

T. F. **PERRINE,** Electrical Engineer, Ebasco Services, Inc, New York, N. Y.

| Circular Mils or AWG Aluminum | No. of Strands Al | No. of Strands Steel | Outside Diameter In. | GMR, Geometric Mean Radius, In. | Single Conductor | $X_a$** 60-Cycle Inductive Reactance, Ohms per Conductor-Mile — 2-Conductor Spacing, In. 6 | 9 | 12 | 15 | 18 | 3-Conductor Triangular Spacing, In. 6 | 9 | 12 | 15 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,590,000 | 54 | 19 | 1.545 | .6240 | .359 | .2214 | .1968 | .1794 | .1658 | .1548 | .1757 | .1429 | .1196 | .1016 | .0868 |
| 1,510,500 | 54 | 19 | 1.506 | .6084 | .362 | .2230 | .1984 | .1810 | .1674 | .1564 | .1767 | .1439 | .1206 | .1026 | .0878 |
| 1,431,000 | 54 | 19 | 1.465 | .5916 | .365 | .2247 | .2001 | .1826 | .1691 | .1580 | .1778 | .1450 | .1217 | .1037 | .0889 |
| 1,351,000 | 54 | 19 | 1.424 | .5748 | .369 | .2264 | .2018 | .1844 | .1708 | .1597 | .1790 | .1462 | .1229 | .1049 | .0901 |
| 1,272,000 | 54 | 19 | 1.382 | .5580 | .372 | .2282 | .2036 | .1862 | .1726 | .1616 | .1802 | .1474 | .1241 | .1061 | .0913 |
| 1,192,500 | 54 | 19 | 1.338 | .5400 | .376 | .2302 | .2056 | .1881 | .1746 | .1635 | .1815 | .1487 | .1254 | .1074 | .0926 |
| 1,113,000 | 54 | 19 | 1.293 | .5220 | .380 | .2322 | .2077 | .1902 | .1767 | .1656 | .1829 | .1501 | .1268 | .1088 | .0940 |
| 1,033,500 | 54 | 7 | 1.246 | .5040 | .385 | .2344 | .2098 | .1926 | .1845 | .1677 | .1843 | .1515 | .1282 | .1102 | .0954 |
| 954,000 | 54 | 7 | 1.196 | .4836 | .390 | .2369 | .2123 | .1948 | .1813 | .1702 | .1859 | .1532 | .1299 | .1119 | .0971 |
| 900,000 | 54 | 7 | 1.162 | .4692 | .393 | .2387 | .2141 | .1967 | .1831 | .1721 | .1872 | .1544 | .1311 | .1131 | .0983 |
| 874,500 | 54 | 7 | 1.146 | .4632 | .395 | .2395 | .2149 | .1974 | .1839 | .1728 | .1877 | .1549 | .1316 | .1136 | .0988 |
| 795,000 | 54 | 7 | 1.093 | .4416 | .401 | .2424 | .2178 | .2003 | .1868 | .1758 | .1896 | .1568 | .1336 | .1155 | .1008 |
| 795,000 | 26 | 7 | 1.108 | .4500 | .399 | .2412 | .2166 | .1992 | .1857 | .1746 | .1889 | .1561 | .1328 | .1148 | .1000 |
| 795,000 | 30 | 19 | 1.140 | .4716 | .393 | .2391 | .2138 | .1964 | .1828 | .1718 | .1870 | .1542 | .1310 | .1129 | .0982 |
| 715,500 | 54 | 7 | 1.036 | .4188 | .407 | .2456 | .2211 | .2036 | .1900 | .1790 | .1918 | .1590 | .1357 | .1177 | .1029 |
| 715,500 | 26 | 7 | 1.051 | .4260 | .405 | .2446 | .2200 | .2025 | .1890 | .1779 | .1911 | .1583 | .1350 | .1170 | .1022 |
| 715,500 | 30 | 19 | 1.081 | .4464 | .399 | .2418 | .2172 | .1997 | .1862 | .1751 | .1921 | .1593 | .1360 | .1180 | .1032 |
| 666,500 | 54 | 7 | 1.000 | .4044 | .412 | .2478 | .2232 | .2057 | .1922 | .1811 | .1932 | .1604 | .1371 | .1191 | .1043 |
| 636,000 | 54 | 7 | 0.977 | .3948 | .414 | .2492 | .2246 | .2072 | .1936 | .1826 | .1942 | .1614 | .1381 | .1201 | .1053 |
| 636,000 | 26 | 7 | 0.990 | .4020 | .412 | .2481 | .2235 | .2061 | .1925 | .1815 | .1934 | .1606 | .1374 | .1193 | .1046 |
| 636,000 | 30 | 19 | 1.019 | .4212 | .406 | .2453 | .2207 | .2032 | .1897 | .1786 | .1916 | .1588 | .1355 | .1174 | .1027 |
| 605,000 | 54 | 7 | 0.953 | .3852 | .417 | .2507 | .2261 | .2087 | .1951 | .1841 | .1952 | .1624 | .1391 | .1210 | .1063 |
| 605,000 | 26 | 7 | 0.966 | .3924 | .415 | .2496 | .2250 | .2075 | .1936 | .1829 | .1944 | .1616 | .1383 | .1203 | .1056 |
| 556,500 | 26 | 7 | 0.927 | .3756 | .420 | .2523 | .2277 | .2102 | .1967 | .1856 | .1962 | .1634 | .1401 | .1221 | .1073 |
| 556,500 | 30 | 7 | 0.953 | .3936 | .415 | .2494 | .2248 | .2074 | .1938 | .1828 | .1943 | .1615 | .1382 | .1202 | .1054 |
| 500,000 | 30 | 7 | 0.904 | .3732 | .421 | .2526 | .2280 | .2106 | .1970 | .1860 | .1964 | .1634 | .1404 | .1223 | .1076 |
| 477,000 | 26 | 7 | 0.858 | .3480 | .430 | .2568 | .2322 | .2148 | .2012 | .1902 | .1993 | .1665 | .1432 | .1252 | .1104 |
| 477,000 | 30 | 7 | 0.883 | .3648 | .424 | .2540 | .2294 | .2119 | .1984 | .1873 | .1974 | .1646 | .1413 | .1233 | .1085 |
| 397,500 | 26 | 7 | 0.783 | .3180 | .441 | .2623 | .2377 | .2203 | .2067 | .1957 | .2029 | .1701 | .1468 | .1288 | .1140 |
| 397,500 | 30 | 2 | 0.806 | .3336 | .435 | .2594 | .2348 | .2173 | .2038 | .1928 | .2010 | .1682 | .1449 | .1269 | .1121 |
| 336,400 | 26 | 7 | 0.721 | .2928 | .451 | .2673 | .2427 | .2253 | .2117 | .2007 | .2063 | .1735 | .1502 | .1322 | .1174 |
| 336,400 | 30 | 7 | 0.741 | .3060 | .445 | .2647 | .2400 | .2226 | .2091 | .1980 | .2045 | .1717 | .1484 | .1303 | .1156 |
| 300,000 | 26 | 7 | 0.680 | .2760 | .458 | .2709 | .2463 | .2289 | .2153 | .2043 | .2087 | .1759 | .1526 | .1345 | .1198 |
| 300,000 | 30 | 7 | 0.700 | .2892 | .452 | .2681 | .2435 | .2260 | .2125 | .2014 | .2068 | .1740 | .1507 | .1326 | .1179 |
| 266 800 | 26 | 7 | 0.642 | .2604 | .465 | .2745 | .2499 | .2324 | .2189 | .2078 | .2110 | .1782 | .1549 | .1369 | .1221 |
| 266 800 | 6 | 7 | 0.633 | .0821 | .605 | .3447 | .3201 | .3026 | .3034 | .2780 | .2577 | .2249 | .2016 | .1836 | .1688 |
| 4/ | 6 | | 0.563 | .0977 | .581 | .3340 | .3094 | .2919 | .2784 | .2673 | .2507 | .2179 | .1946 | .1765 | .1618 |
| 3/0 | 6 | | 0.502 | .0720 | .621 | .3525 | .3279 | .3104 | .2957 | .2858 | .2630 | .2302 | .2069 | .1889 | .1718 |
| 2/ | 6 | | 0.447 | .0612 | .641 | .3623 | .3378 | .3203 | .3068 | .2957 | .2696 | .2368 | .2135 | .1954 | .1807 |
| | | | 0.398 | .0535 | .656 | .3701 | .3455 | .3280 | .3145 | .3034 | .2750 | .2422 | .2189 | .2009 | .1861 |

Inductive reactance varies directly with frequency.

**$X_a$ is the component of inductive reactance due to all the flux within a one-foot radius and equals for 60-cycle current 0.2794 $\log_{10} \frac{1}{GMR}$ where GMR is defined as the geometric mean radius of an infinitesimally thin tube with the same internal inductance as the conductor. The remaining component of inductive reactance $X_d$ is that due to other phase or current return wires and is equal to 0.2794 $\log_{10} d$ where d is the geometric mean distance between phase wires.

The total inductive reactance per phase is the sum of $X_a$ and $X_d$. Because the $X_d$ factor is not affected by bundling it may be obtained from the usual tabular sources of such data on single-conductor-per-phase lines.

Printed with the permission of and republication rights reserved by Ebasco Services Inc

† A table listing shunt capacitive reactive characteristics of ACSR bundled conductors at 60 cycles will be published in a subsequent issue of Electrical World.

# Up to 10% lower losses, 3-db lower sound in

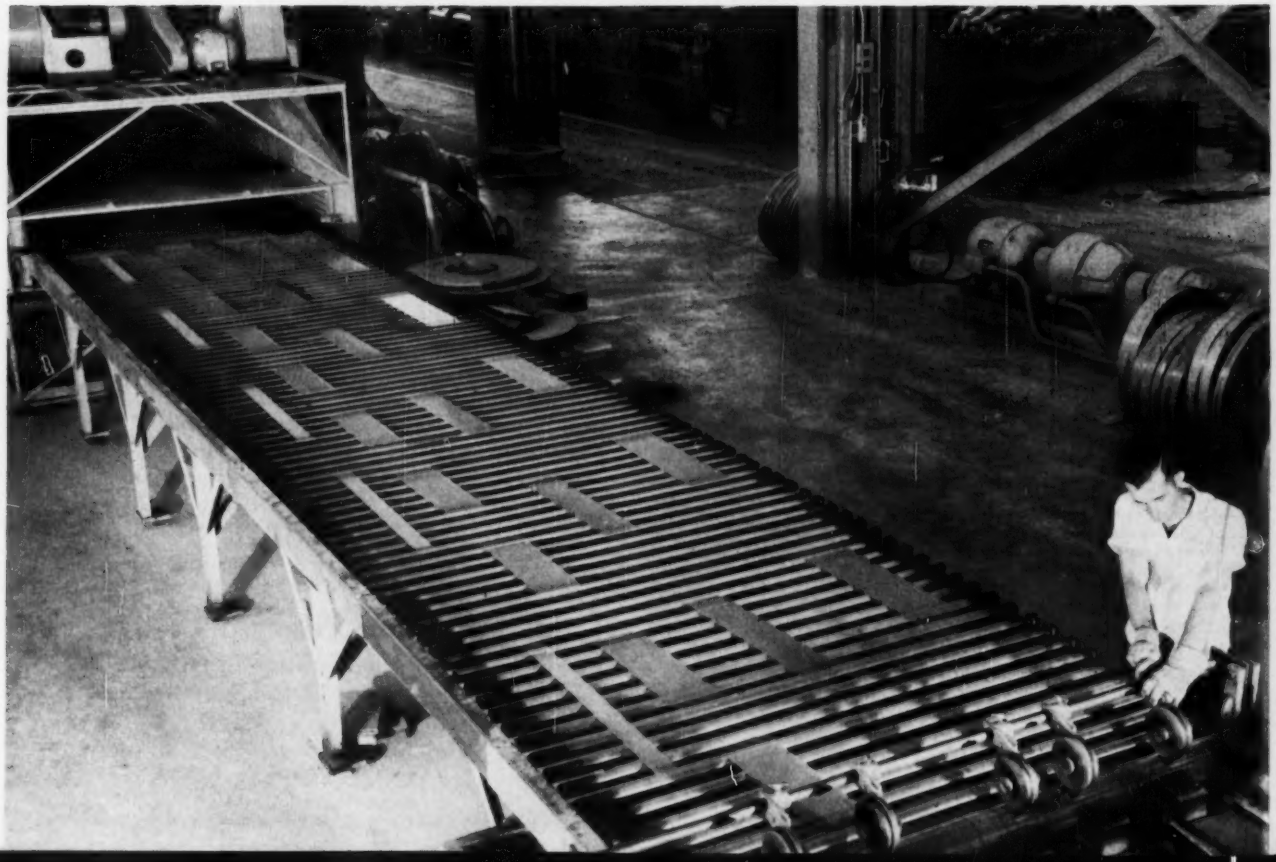
Core losses up to 10 percent lower than previous models and guaranteed sound levels 2 to 3 db below present industry standards are 1959 features of General Electric's entire line of medium* transformers. In addition, excitation currents of G-E medium transformers also have been reduced approximately 15 percent.

These superior characteristics of new General Electric medium transformers result from use of a new continuous annealing process for core steel. As a result, core plate insulation has been improved by 85 percent, giving better distribution of impulse voltages across the core. Edge or ripple factor has been decreased by 50 percent so that the steel has flatter characteristics, resulting in a tighter core. Watts loss-per-pound for individual laminations has been reduced eight percent.

Shown below are core laminations emerging from the annealing furnace. Here they receive individual stress-relief anneals at lower temperatures than required in batch-type annealing and without damaging effects caused by temperature gradients. Another example of General Electric's continuing transformer leadership is the emphasis placed upon research and development as depicted here by the Medium Transformer Department's anechoic sound chamber where sound level studies are conducted.

*501 to 7500 kva, 69 kv and below.

## NEW LAMINATION PROCESS



# G-E medium transformers

Product leadership is just part of our story. General Electric medium transformers are certified to deliver **full value** for your transformer dollar . . . in terms of superior products . . . plus faster order handling and shipment . . . plus complete service before, during, and after installation. When deciding on your next medium transformer, examine the **complete "package"** offered by General Electric. When you do, we're confident that you'll recognize General Electric superiority and how you get full value for your transformer dollar.

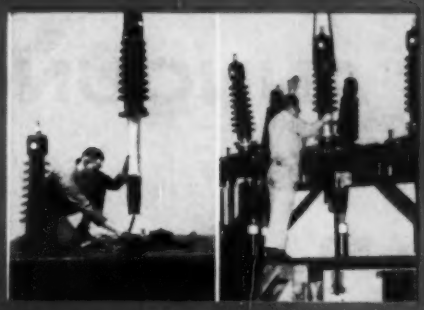
Your G-E Apparatus Sales Engineer can show you all the ways you get full value for your transformer dollar with General Electric. Ask him today for full details on the Certified Full-value Transformer Program. General Electric Company, Schenectady 5, New York. 416-27

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

## ANECHOIC SOUND CHAMBER

## FULL VALUE FOR YOUR TRANSFORMER DOLLAR



**SUPERIOR DESIGN, FEATURES, AND PERFORMANCE** of G-E transformers is typified by new interchangeable transformer-circuit breaker bushings (above), and improved Formex† insulation (below).

**FASTER SHIPMENT** through rapid processing of orders . . . computer design capability . . . repetitive manufacturing facilities.

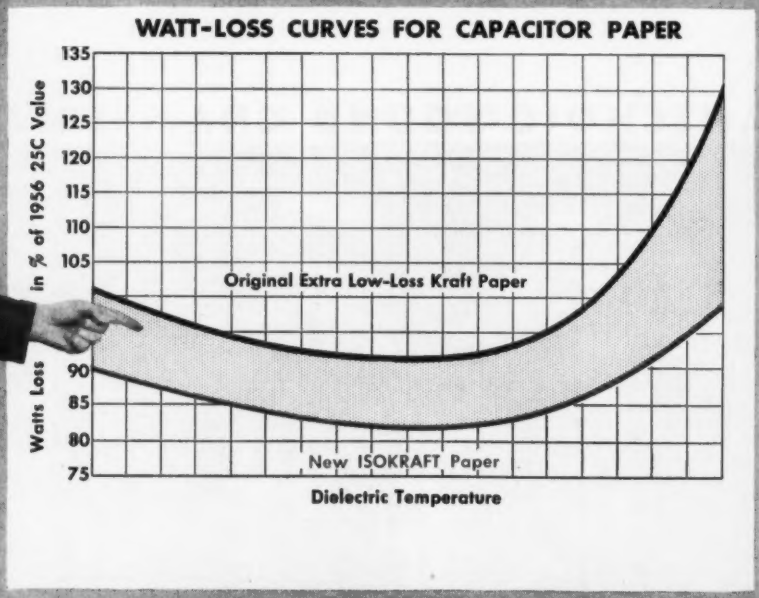
**COMPLETE SERVICE** . . . application and systems engineers . . . installation engineers . . . 50 conveniently located service shops.

† Reg. Trade-mark of General Electric Co.

# GENERAL ELECTRIC ANNOUNCES...

# NE

# "ISOKRAFT 50"




**NEW ISOKRAFT† PAPER WITH GREATER DIELECTRIC STRENGTH . . .** multiplies G-E capacitor benefits through improved electrical characteristics. R. J. Hopkins, Manager of Power Capacitor Engineering, points to loss reduction, which is greatest at higher temperatures. Result: greater thermal stability, longer, more reliable capacitor life for "ISOKRAFT 50" capacitors. ISOKRAFT paper is covered by patent No. 2505545.

**14 percent lighter than previous General Electric units*

*†Trade-mark of the General Electric Co.*

# W CAPACITORS

- **LONGER LIFE—**
  **through 20% lower temperature rise**
- **MORE RELIABLE—**
  **because of greater thermal stability**
- **EASIER TO INSTALL—**
  **with 14% weight reduction**

General Electric's new ISOKRAFT† paper dielectric, with other manufacturing and design improvements, now gives you smaller 50-kvar capacitors with greater reliability, longer life, easier installation.

**LONGER LIFE**—20% lower temperature rise permits cooler operation, lengthens capacitor operating life.

**GREATER RELIABILITY**—ISOKRAFT paper has a superior loss-versus-temperature characteristic (see chart left). The result is a more thermally stable unit.

**EASIER TO INSTALL**—14% reduction in weight and smaller size make installation faster, easier, permits more kilovars per pole: 600-kvar equipments replace 450-kvar equipments, with no weight increase.

**FOR COMPLETE INFORMATION** on "ISOKRAFT 50" capacitors, write for bulletin GEA-6990—Section 445-27, General Electric Co., Schenectady, N. Y.

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

# Procurement & Products

**STEEL** ▶ **Prospects brighten for steel price stability** as U.S. Steel's Roger Blough commits his company to leave prices alone if "voluntary" agreement is reached with striking union. If government forces an "over-generous" settlement, all bets are off. But there's little likelihood that President Eisenhower will move in before Labor Day. Competition from aluminum and from foreign steel will also put a damper on steel price hikes.

**From ore to steel without melting** is already a laboratory reality and could eventually be a commercial process. Long term result: Lower production costs and the possibility of lower prices.

**ALUMINUM** ▶ **"Chances of a strike in aluminum industry appear practically eliminated,"** says Engineering & Mining Journal's weekly markets newsletter, a McGraw-Hill publication. But the letter reiterates that price rises are almost certain despite the fact that the industry is operating at only 87% of capacity. It notes that a rise came last year when the industry was operating at 70% of capacity.

**PRICES** ▶ **General Electric Co announces another price reduction**—this time on current limiting fuses. Cuts of 10% to 20% are effective on the EJ-type. Such fuses are used as back-up protection for motor-starter gear, capacitor-rack equipment, high-voltage industrial equipment, and capacitor energy storage banks. The reductions affect EJ-1 and 2, EJO-1, 2, and 3 in size D and DD. GE's policy of issuing 20% discount on returned blown EJ type fuses is discontinued.

**FLY ASH** ▶ **TVA finds fly ash market** for output from the Colbert steam plant. The government agency will sell to Dixie Fly Ash Corp of Tuscumbia, Ala., a newly formed company. The ash is to be used by producers of concrete products to improve the quality of such products while saving in the amount of cement normally used, says TVA.

**SERVICES** ▶ **What type of manufacturers' service rates highest with purchasing agents?** Sample survey conducted by Electrical World indicates "application and design engineering" was most important on all generation equipment and heavy apparatus such as power transformers, large circuit-breakers, etc. "Production and delivery service" rated second. Tying for third and fourth ratings were "installation service" and "commercial service."


News of Manufacturers ..... page 56
New Equipment ..... page 59
Readers Service ..... page 64

*An open letter to the Power Industry*

# VICTOR HAS BEEN SUPPLYING YOU WITH 18,000 LB. SUSPENSIONS

# SINCE 1952

VICTOR NO. 900
Suspension Insulator

VICTOR'S 15,000 lb. minimum M & E Suspension Insulators easily comply with 18,000 lb. M & E specification . . . and have been doing so since 1952 when we accomplished the first major insulator improvement in years with the development of Purified Porcelain. These are the Victor suspensions you have been using on your lines for the past seven years.

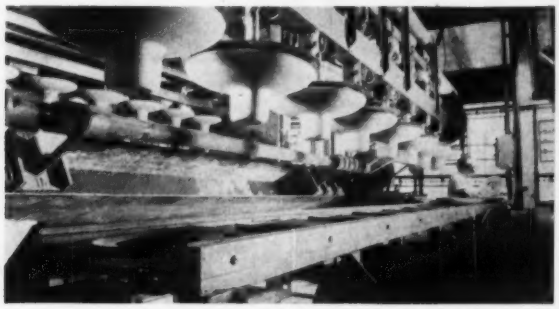
Therefore, effective immediately, we offer you *field-proven, guaranteed 18,000 lb. suspensions.* This rating will hereafter be guaranteed on insulators formerly of the 15,000 lb. M & E class.

Of particular interest to you is the fact that Victor is producing these insulators now for *immediate delivery.* In addition, all these insulators now in our stocks throughout the country are covered by this 18,000 lb. guarantee.

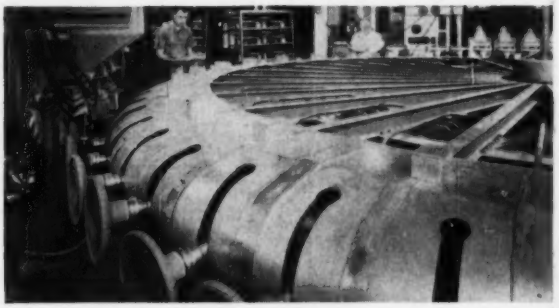
Check your service records and use *proven* 18,000 lb. suspension insulators from Victor.

I-T-E CIRCUIT BREAKER COMPANY

VICTOR INSULATORS DIVISION
Victor, N.Y.



**INSULATORS ARE TRANSFERRED** to conveyor gently by vacuum-gripping devices, following removal from the mold



**SHAPED CLAY IS TRANSFORMED** into pieces ready for kiln firing by this finishing machine, which also glazes

# OB's New Facility Will Make Futura Insulators

Ohio Brass Company of Mansfield, Ohio, has opened a new "million-dollar-plus" facility which will be devoted principally to mechanized manufacture of the Futura suspension insulator series which was announced August 1.

The new facility includes a specially designed building for the porcelain-making phase of the manufacture of the new insulator series: new pug milling equipment which handles clay filter cakes in 2,800-lb batches; more than 1¼ miles of new conveyor system; and an automated system for making high- and low-frequency electrical tests.

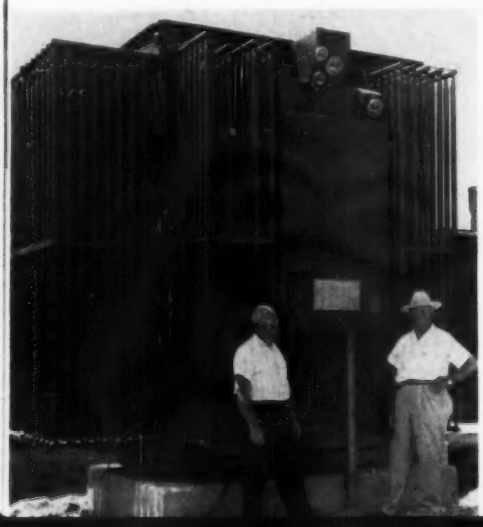
Futura insulators feature the corrosion intercepting sleeve for protection against corrosion stress and incorporate "improved" methods of loading porcelain, according to Ohio Brass.

Says George L. Draffan, OB's board chairman, "The new design calls for precise control of raw materials, of manufacturing operations, and of testing. We are confident that the investment in new facilities to make the Futura design is justified by the tremendous growth prospects for the electric power industry. It's our responsibility to make sure the insulators are available when needed and, just as important, to make sure they are designed for tomorrow's operating conditions."

OB's new porcelain-making machinery has the capacity to process more than 60 tons of clay during an eight-hour shift, and with other recent improvements in equipment, increases the company's suspension insulator production capacity by 60%.

The Futura insulator design offers high strength with less weight and no increase in diameter, says OB. Cap, pin and disc shapes have been changed to gain increased mechanical and dielectric strength from the porcelain but with use of less material.

Several aspects of the new facility's capacity for handling large quantities of material contribute to a high degree of product uniformity, the company points out. For example, bulk milling of filter cakes results in a cross-blending of 2,800 lbs of material at one time, and the broader the blend the greater the uniformity and homogeneity of the material. Also, the influence of environment in upsetting product uniformity has been virtually eliminated by speeding up the operation at many points and by artificial control of environment at others. Thus, such variable factors as moisture and temperature can be adjusted more successfully than was previously possible. In addition, the human element has been removed from the stages of the operation in which variations in judgment would affect product uniformity.



## Substation Marks Dual Milestone

Installation of this 5,000-kva load-tap-changing transformer on the line of the Utility Service Board, Jasper, Ind., marked a milestone for both the municipal utility and for the manufacturer, General Electric.

Shown at the installation site are Robert W. Wade (left), board superintendent, and Allen F. Joseph, board chairman.

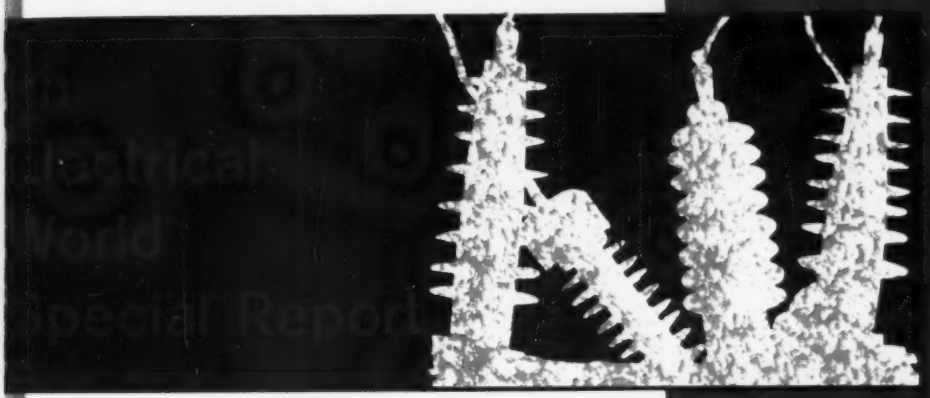
The unit completed a three-year expansion program which enables the utility to carry the load for its entire area in an emergency. The city now buys some of its power from an outside supplier and uses existing generating facilities as a firm power supply.

The transformer was the 12,000th of its kind manufactured by GE's Medium Transformer Department, Rome, Ga., and was notable as a "fifth anniversary special" for the plant.

# INDUSTRIAL ELECTRICAL SYSTEMS

KENNETH N. McLEAN • INDUSTRIAL EDITOR

AUGUST 1959



Survey of Industrial Distribution System Design Practice ..... p 65

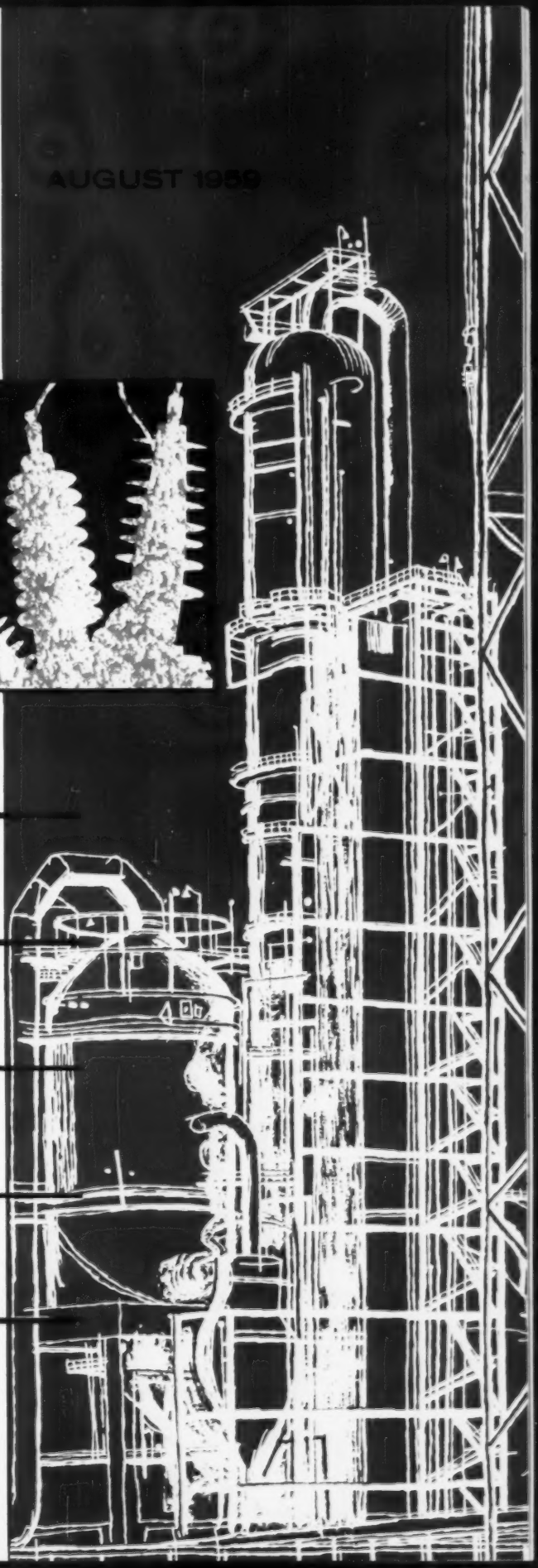
More for Your Transformer Dollar? Take Another Look at Real Costs.. p 70

4 Kv or 13 Kv . . . Which Voltage is Best for 10- to 20-Mva Systems?.. p 76

Reliable 13-Kv Radial Powers Large Compressor Drives ..... p 82

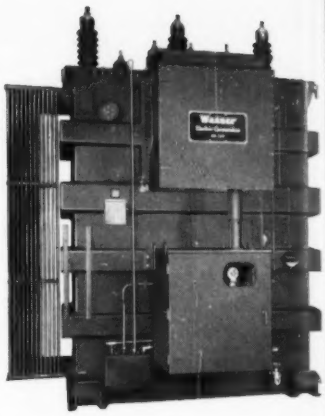
19 Ways To Get More Protection From Your System Relay Plan .... p 84

Simple Method Speeds Industrial Short Circuit Calculations ..... p 92



# WAGNER LOAD TAP CHANGING TRANSFORMERS

***offer new simplicity of design . . . new quietness of operation . . . new freedom from maintenance***



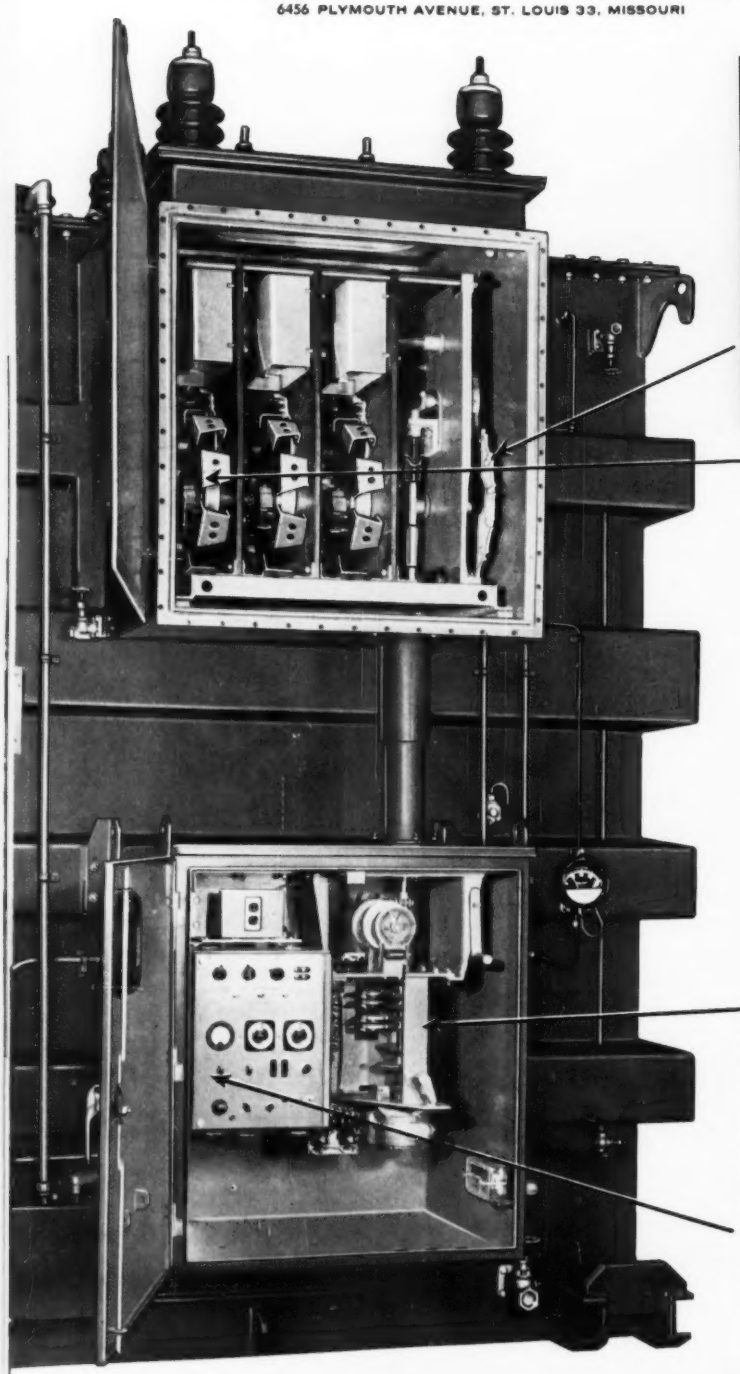
Here is a compact, extremely simple power transformer load tap changing mechanism, using a single drive shaft and one set of miter gears to assure quiet operation. Magnetic amplifier control means higher accuracy in the voltage sensing circuit, and greater reliability since no moving parts are necessary.

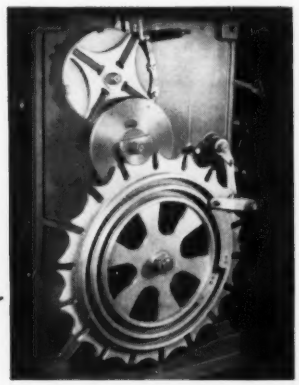
The design simplicity of the Wagner load tap changer . . . in the drive mechanism, the transmission assembly, the switches and the control circuit . . . results in long, efficient operating life with freedom from maintenance.

For full information on these Load Tap Changing Power Transformers, consult your nearby Wagner Sales Engineer. There are Wagner branches in 32 principal cities.

**Wagner Electric Corporation**

6456 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI



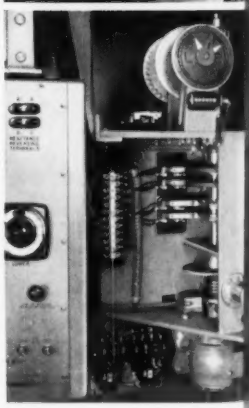


### ONLY 2 GENEVA GEARS

The two Geneva gears operate from a single drive pinion, and are designed for 90° entrance to reduce noise of operation. The reversing switch operates from a cam in the face of the tap selector gear which has a positive mechanical stop to prevent overtravel.

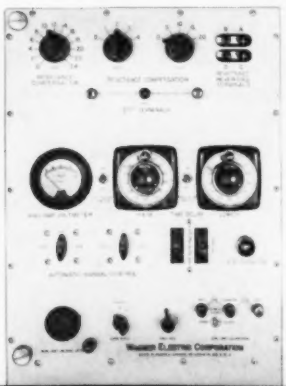
### MAXIMUM LIFE CONTACTS

All switch contacts, both moving and stationary, are alloyed copper for maximum resistance to wear . . . reliability proved by life tests far exceeding normal operating conditions. Moving contacts self-aligning . . . free parallelogram action assures maximum contact area with constant pressure.



### SINGLE SHAFT DRIVE

A single main drive shaft, geared to the drive motor and to the drive pinion, operates the tap selector switch and the load transfer switch. This shaft also operates the position locating switches and the position indicator.



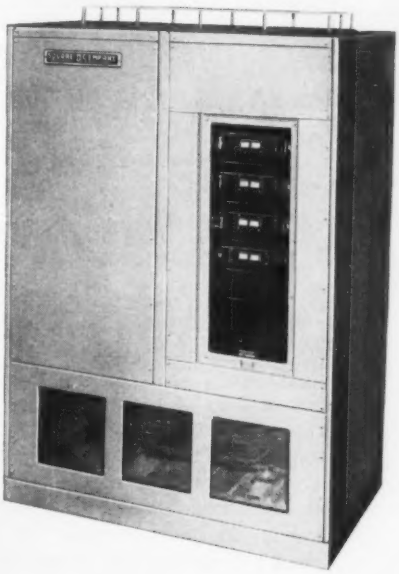
**MAGNETIC AMPLIFIER CONTROL** Magnetic amplifier control eliminates moving contacts in the voltage sensing circuit . . . provides simplified and high accurate band width control.

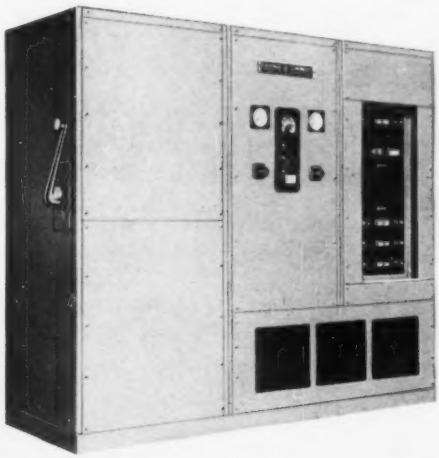
WT59-14

# New Equipment

(For further information refer to Reader Service on page 64)

## Unit Substations . . .

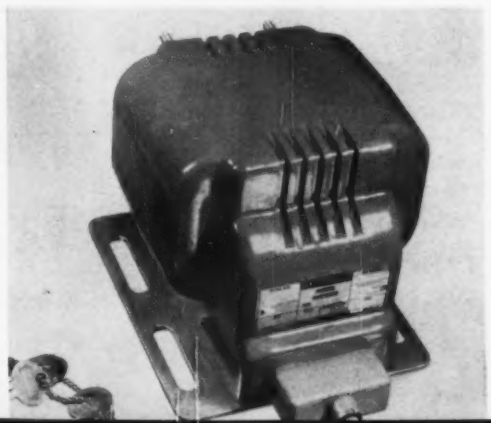




**. . . feature compact construction.** The Power-Zone model above measures 79½ in. high, 94 in. long and 36 in. deep in capacities from 75 to 300 kva. High voltages range up to 4,800 v and low voltages to 600 v. High-voltage section may be ordered with either an air interrupter switch or oil cutouts, with or without fuses. The low-voltage model at left, for use on 480-v systems to supply 120/208 v, measures 60 in. long, 36 in. deep and 79½ in. high. Designed for lighting, office equipment and similar loads, substations contain 3-phase transformers from 75 to 300 kva.
**Square D Co, 6060 Rivard St, Detroit 11, Mich.**

## Packaged Drives . . .

**. . . with static power conversion** use light, compact components to replace conventional motor-generator set. Known as Ultraflex Packaged Drives, the adjustable speed dc units are available in two forms: Ultraflex E, a 1 to 40 hp electronic adjustable speed drive; and Ultraflex M, a 1 to 200 hp magnetic amplifier adjustable speed drive. Drives include enclosed panel for conversion and control, operator's station, and an industrial dc motor.
**Cutler-Hammer, Inc, 315 N 12th St, Milwaukee 1, Wis.**



## Potential Transformer . . .

**. . . for metering applications is available** in ratios of 2/1, 2.4/1, 4/1 and 5/1 in either 600-v class (10-kv BIL) or 1,200-v class (30-kv BIL). The Type EMPL molded transformer is designed to maintain metering accuracies through 75 va at 85% p.f. In the 1,200-v class, it is available with or without fuses.
**Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.**

(*More New Equipment on page* 60)

# How to "specify" splices that will last as long as the cable

You can specify "failproof" splices by specifying the same kind of insulation for the splice that you do for the cable.

The compound used for insulating a cable is specifically designed for its job. Therefore, when a portion of the insulation is removed in making the splice, it stands to reason that the insulation should be replaced with the same material—with a true cable-insulating compound.

Fortunately, there are splice insulating tapes made of true cable compounds. They're Okonite and Okolite tapes. Made from fine Para rubber, unexcelled for physical characteristics, Okonite and Okolite tapes fuse into a solid, layerless, non-porous wall of insulation that has excellent moisture resistance, no voids to cause failure, and no adhesives to dry out, ooze, or cause slippage of the tape wrappings. Okonite and Okolite actually become an integral part of the cable's insulation, not a weak "link" in it.

Like to try some of this tape? Let Okonite pay for your first roll. Ask for either or both of the tapes. Just fill in this coupon and send it to Okonite.

**The OKONITE Company**

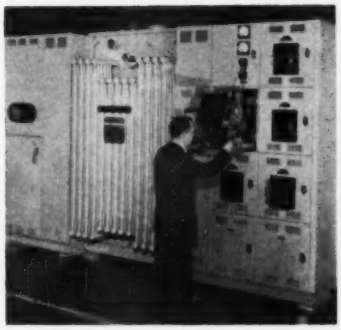
Subsidiary of
Kennecott Copper Corporation
Passaic, New Jersey

Dept. EW 8-10
The Okonite Company
Passaic, New Jersey
Please check one or both.
.....Okonite tape (yellow can—for use up to 2000 volts).
.....Okolite tape (red can—for use up to 35,000 volts).
Name .....
Title .....
Company .....
Address .....
City .....Zone....State .....

6654


## Secondary Unit Substations . . .

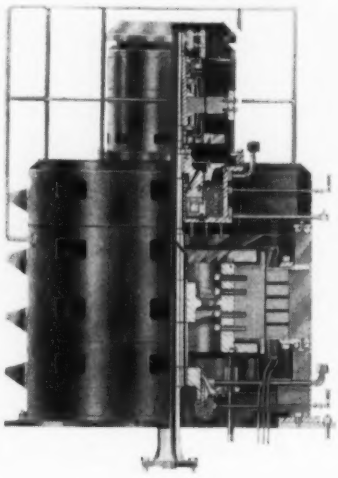
**. . . in both indoor and outdoor models** are available in sizes ranging from 75 through 2,000 kva. Both articulated and integrated designs can be furnished. Articulated-type substations range from 112½ through 2,000 kva, and integrated substations range from 75 through 500 kva. Primary voltages are from 2,400 through 13,800 v, with secondary voltages 480 v and below. Outgoing feeder switchgear—normally of the 600-v insulation class—may include either low voltage power circuit breakers or molded-case breakers.



**Pennsylvania Transformer Div, McGraw-Edison Co, Canonsburg, Pa.**

## Vertical Motors . .

**. . . in sizes of 150 hp and up,** frames 584 and larger are now available. The high-speed synchronous motors feature a double-end ventilation system which assures maximum cooling efficiency. In addition to standard A, B and H insulations, the manufacturer can supply a number of special materials, including silicone rubber, acrylic and epoxy resins and other materials to meet unusual moisture, ambient and chemical conditions.



**Ideal Electric and Mfg Co, Mansfield, Ohio.**

## Low Voltage Motor Controls . . .

**. . . take less floor space** and are suitable for installing in low ceiling areas and against walls. The new line, for 600 v and below, is built with three starting options—full voltage, reduced voltage and part winding. Depending on back up protection, controls are offered with isolating switch only, isolating switch and current limiting fuses, circuit breaker only, or circuit breaker and current limiting fuses.

**Electric Machinery Mfg Co, Minneapolis 13, Minn.**

## Cycle Timer . . .

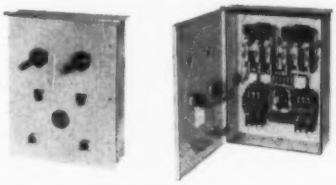
**. . . controls processes based on timed operations.** The impulse-sequence controller, known as Model C1C500, can time control as many as ten different variables. Ten pilots—pneumatic, electric, or a combination—may be op-

erated simultaneously or in any sequence. Variations offer high-capacity pneumatic pilots; spdt, dpdt and special switches.
**The Bristol Co, Waterbury 20, Conn.**

---

## Pump Controls . . .

**. . . are designed for control of motors** on twin pump installations where two pumps operate either individually or in conjunction. The Type "DP" controls



provide a disconnect means for every motor, either through the use of a disconnect switch, fusible or nonfusible, or a thermal magnetic trip circuit breaker in series with the starter and the load.
**Arrow-Hart & Hegeman Electric Co, 123 Hawthorn St, Hartford, Conn.**

(*More New Equipment on p* 62)

**Reduces Structural Supports 50%!**

When the chips are down, it's the *installed* cost that counts . . . whether it is a self-grounding, maintenance free Husky extra-strength cable support system or an ordinary one. And now, Husky brings you the substantial time, labor and material savings of "Long-Span" Design.

Want proof and details? Write for "Long-Span" Design data or send us your cable support problem (indoor-outdoor) for analysis.

*Representation from coast to coast*

HUSKY PRODUCTS, INC.

5308 Vine Street Cincinnati 17, Ohio

## SPECIAL ZINC-RICH COATING GIVES GALVANIC PROTECTION TO METALS

Galvanox is a special coating composed of an extremely high percentage of metallic zinc in an organic binder. The resulting film supplies an electro-chemical type of protection long associated with galvanizing. Applied as a paint, it dries and "cures" to form a very dense coating of metallic zinc.

Galvanox comes ready-mixed in a natural zinc color only and has specialized uses and applications, as:

- For replacing galvanizing
- For reconditioning galvanizing
- For covering arc welds and welding
- For use in conjunction with cathodic protection
- For use as an electrical conductor
- For minimizing electrolysis
- For use as a metal filler
- For underwater, underground or high humidity exposures.

Learn more about the application of Galvanox and its low cost. Write today for a copy of "Galvanox by Subox."

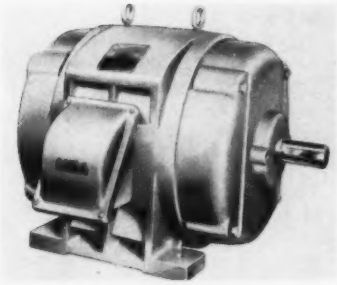
SUBOX PAINTS

Subox Inc.

*Established 1924*

3 Fairmount Plant, Hackensack, N. J.

Subox Company of Canada, Weston, Toronto 15

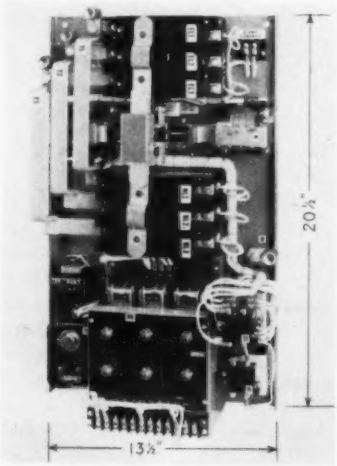


## Induction Motors . . .

**. . . are available in NEMA re-rated frame sizes.** The dripproof motors have die cast aluminum rotors and are offered in sizes from ½ hp at 900 rpm to 150 hp at 3,600 rpm—frames 182 through 445 URS. They can be furnished either 3 or 2-phase in all frequencies and commercial voltages below 600 v.

**Lima Electric Motor Co, Inc, Dept 75, Lima, Ohio.**

---



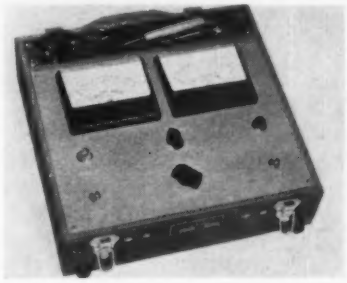

## Transfer Switch . . .

**. . . employs dual circuit breaker design** that uses two opposing solenoids through a common transfer linkage. Available to 600 v, 100 amp, the T-100A switch affords interrupting capacities to 10,000 amp rms. It is available for ac or dc applications for ratings to 600 v ac and 250 v dc. Circuits available include total failure protection and partial failure protection.

**Lake Shore Electric Corp, Bedford, Ohio.**

## Insulation Test Set . . .

**. . . provides leakage current tests** of insulation on every type of industrial equipment, ranging from 115 to 2,500-v equipment. The HYPOTR Model 5205 has a test

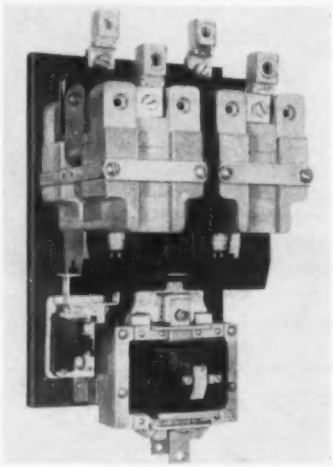


voltage continuously variable from 0 to 5,000 v dc. The self-contained power supply operates from 115 v ac.
**Associated Research, Inc, 3777 W Belmont Ave, Chicago 18, Ill.**

---

## Dc Contactor . . .

**. . . in 150-amp standard NEMA size 4** model is now available. The single and double-pole units are designed for use in general



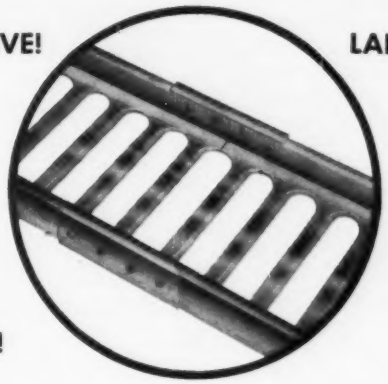
purpose and machine tool controllers and for switching lamp, battery and other dc loads. Standard coils are offered for 115 and 230-v dc operation.
**Ward Leonard Electric Co, Mount Vernon, N. Y.**

(*More New Equipment on p* 64)


# *Now* P-W BRINGS YOU TYPE "E" TRAYS TO HOLD POWER AND CONTROL CABLES AND INSTRUMENT PIPING . . .

**LESS EXPENSIVE!**

**LABOR SAVING!**



**STRONGER!**

**NEATER!**

**VERSATILE!**

**SUPERIOR!**

**GALVANIZED!**

**ALUMINUM!**

Control cables can be dropped out anywhere. Eliminates conventional drop-outs. Furnished in standard widths: 1½" and 3" high in galvanized steel and 3" high in aluminum.

With Type "E", P-W brings *you* another *First*. P-W has been the leader in outstanding improvements in cable and tubing supports, among which are: Connectors that are quick and easy to put together with drive rivets. A pre-cut system that saves countless hours in installation time. Extension Connectors to eliminate field cutting in completing runs. Adjustable Horizontal and Riser Connectors so workmen can make runs over and around pipes, trusses, columns, etc. (Of great advantage in areas and buildings to go in and around circles, spheres, tunnels, etc.) Built-in Adjustable Drop-out Sections for power and control cables—eliminates cutting out bottom of tray to install conventional drop-outs. Straight sections can be purchased in lengths up to 16′ (33⅓% less connectors and 33⅓% less connection-installation time over 12′ lengths).

P-W also manufactures supports (hot dip galvanized steel and aluminum) in Ladder, Expanded Metal and Solid Trays. All systems, including Type "E", are interchangeable. Write for Catalog No. 858.

Due to increased demands, we have moved to a new, ultra-modern building to triple plant area, increase production facilities and give best possible delivery.

P-W INDUSTRIES, INC. 11200 Roosevelt Blvd. Philadelphia 15, Pa.

*Representatives throughout the country to serve you!*

# Readers Service

**For additional information on new products, supplies, and services in this issue, the Manufacturers Editor of Electrical World offers his facilities. Check items in which you are interested in list below:**

**NEW EQUIPMENT**

Square D .....Substations ☐
Cutler-Hammer .....Drives ☐
Westinghouse .....Transformer ☐
Penn Transformer ....Substations ☐
Ideal .....Motors ☐
Electric Machinery Motor Controls ☐
Bristol .....Cycle Controller ☐
Arrow-Hart .....Pump Controls ☐
Lima .....Motors ☐
Lake Shore Electric .....Switch ☐
Associated Research ....Test Set ☐
Ward Leonard .....Contactor ☐
Fairbanks, Morse .....Motors ☐
Allen-Bradley .....Switches ☐
Square D .....Switchboard ☐

**OTHER**

Manufacturers Editor
Electrical World
330 W. 42nd St.
New York 36, N.Y.

* Note: Requests must be received within four weeks of publication date, accompanied by complete information specified. This service cannot be offered to readers in foreign countries or to competitive manufacturers.

NAME_____

TITLE_____

DEPT._____

COMPANY_____

ADDRESS_____

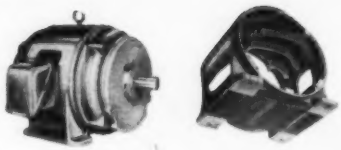
_____

_____

FOR:

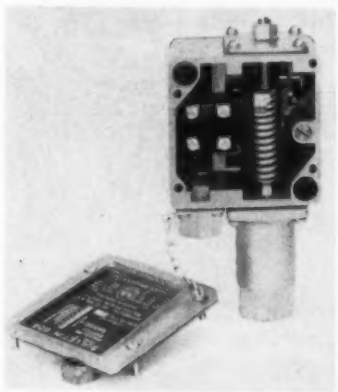
Reference ..... ☐
Specs ..... ☐
Trial ..... ☐
Purchase ..... ☐

**AUGUST 10, 1959**



## Dripproof Motors . . .

**. . . have redesigned and improved enclosure** and ventilating system. The Model KZK motors are available in frames 364U through 445U. The circulating of ventilating air is controlled by a series of integral cast baffles, known as a Spiro-duct cooling system.
**Fairbanks, Morse & Co, 600 S Michigan Ave, Chicago 5, Ill.**



## Pressure Switches

**. . . for machine tool hydraulic systems** operate at pressures up to 5,000 psi. The aluminum enclosure is completely sealed to exclude oil and water. The Bulletin 836 Type T switches have adjustable pressure and differential.
**Allen-Bradley Co, 1316 S Second St, Milwaukee 4, Wis.**

## Switchboard . . .

**. . . has buses stacked vertically** and moved back out of the wiring area. In the Bus Stack switchboard, an optional location of the crossbar is possible and the need for bussed riser sections to transfer cross-bussing to a top or bottom location is, in most cases, eliminated. A depth of 20 in. provides improved circulation.
**Square D Co, 4041 N Richards St, Milwaukee 12, Wis.**

**STEAM POWER PLANTS**
**Starting, Testing, and Operation**

**Just Published!** A complete guide to steam power plants—their physical setup, their various components, and techniques for efficient operation. Follows a steam plant from design and construction, through organizing, personnel and facilities, starting up, procedure development, and arranging test routines to keep up to top economy. **By Charles D. Swift, Mechanical Engr., Ebasco Services, Inc. 490 pp., 6 x 9, 95 illus., $11.50**

**THEORY AND DESIGN OF SMALL INDUCTION MOTORS**

**Just Published!** A practical guidebook and reference that brings you thorough coverage of the engineering, application, and design procedures involved in small induction motors. Describes simply principles and practices, gives performance calculation methods for single- and polyphase motors, covers methods and formulas for analyzing a design, and shows how to design a machine for a specific purpose. **By Cyril G. Veinott, Chief A-C Engr. and Chief Engrg. Analyst, Reliance Electrical and Engrg. Co. 492 pp., 6 x 9, 202 illus. $13.50**

**MATHEMATICS FOR SCIENCE AND ENGINEERING**

A reference book planned especially to help engineers and technicians find, understand, and apply the mathematical procedures best adapted to solve a particular problem simply and quickly. Covers mathematics all the way from arithmetic to such things as complex numbers, infinite series, and methods of approximation. **By Philip L. Alger, Consulting Engineer, General Electric Co. 360 pp., 117 figures, $7.75.**

6 books in one!

**ENGINEERING MANUAL**

For quick answers to engineering problems, *including fields outside your own* — a practical reference of data and methods in architectural, chemical, civil, electrical, mechanical, and nuclear engineering. Covers most-needed essentials — everything from basic principles to applications. Prepared by a staff of specialists. Editor, R. H. Perry, U. of Oklahoma. 680 pp., 450 illus. and tables, $9.50

FREE EXAMINATION

**See These Books On 10-Day Trial**

**McGRAW-HILL BOOK CO., INC., Dept. W-8-10**
**327 W. 41st St., New York 36, N. Y.**

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

☐ Swift—**Steam Power Plants**, $11.50
☐ Veinott—**Th. & Des. Small Induc. Mot.**, $13.50
☐ Alger—**Math. for Scien. & Engrg.**, $7.75
☐ Perry—**Engineering Manual**, $9.50

**(PRINT)**
Name .....
Address .....
City .....Zone.... State.....
Company .....
Position .....

**For price and terms outside U.S. write McGraw-Hill Int'l., N.Y.C.** W-8-10

# Industrial Power Systems Show Steady Progress

**KENNETH N McLEAN,** Northeastern and Industrial Editor

A survey of power system design practice in 60 large industrial companies, representing more than 3,000 Mw of connected load, highlights the rapid development taking place in industrial power systems. Among the survey results:

- 56% have added or replaced main substation capacity in the past three years. Of this total, 71% were outdoor installations and 21% indoor. The remaining 8% added both indoor and outdoor subs.
- 25% have had changes in utility supply, primary, or secondary distribution voltages in the last five years. 18% will have changes in one or more of these voltages by 1963.
- 92% have added significant amounts of primary cable in the past three years.
- 32% indicated an exclusive preference for oil-cooled transformers in secondary substations; 30% for askarel. Although only 13% preferred dry type exclusively, more than 25% indicated they would use it in some applications.
- By far the largest influence on system design is the industrial's own engineering staff, in the local plant and in centralized staffs. However, manufacturers' engineers, utility engineers, and to a lesser extent, consultants, exert strong secondary influences.
- 71% use load center distribution.

### Who The Survey Included

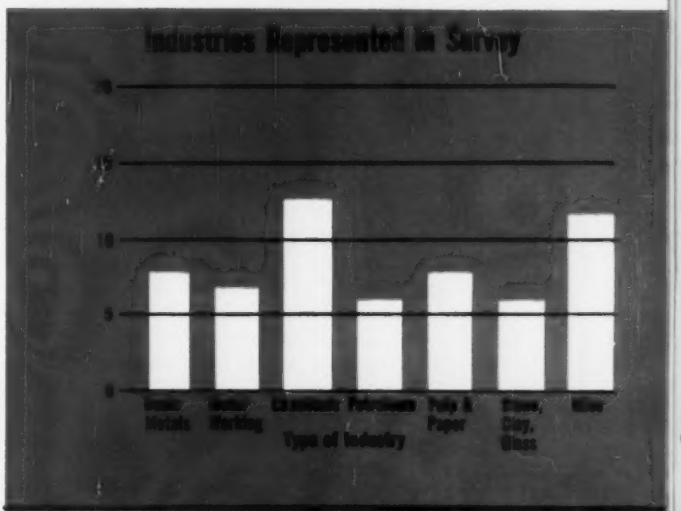
In making the survey, two hundred individuals were selected at random from Electrical World's readers with power system responsibilities in large power-using industries. Completed questionnaires were received from 70 of those individuals. Of these, 60 were considered complete enough to be used.

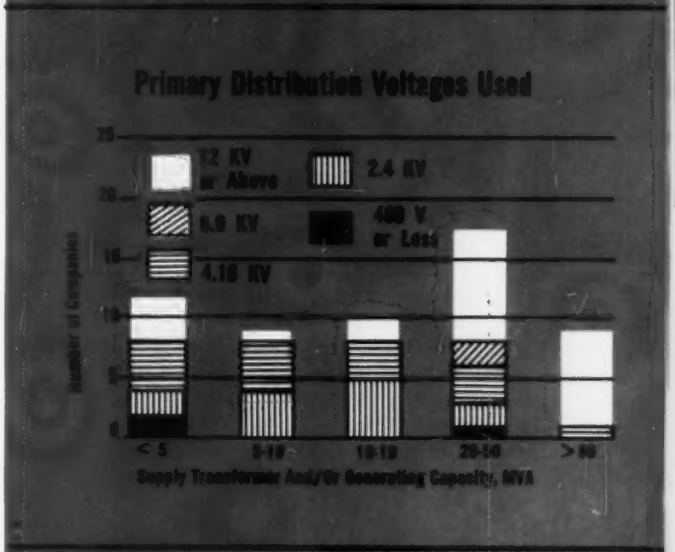
Companies included in the survey were large power users in industries such as basic metals, petroleum, paper, chemicals, metal working, and stone, clay and glass. Excluding one very large company, their total source capacity—generation and main substation capacity—was 2,917 Mva; average capacity, 49.2 Mva.

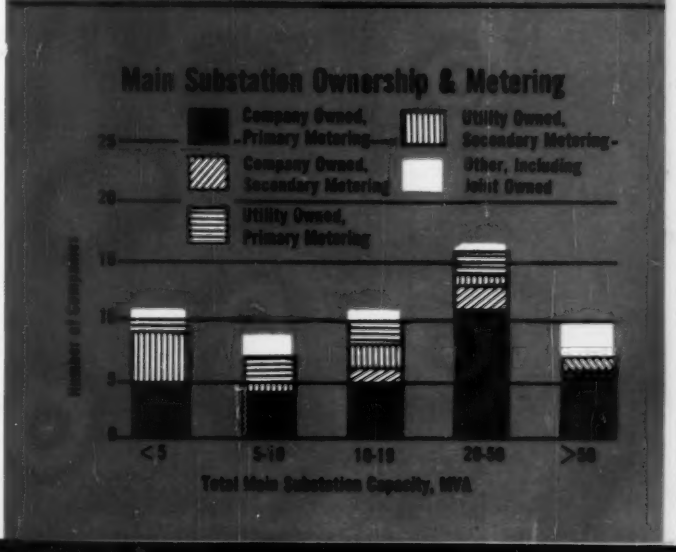
Utility supply voltages range from EHV to 2.4 kv. Approximately 38% are served at 69 kv or higher; 42% between 24 and 60 kv; 15% at 11 to 14 kv; and 5% at lower voltages.

Two-thirds of the reporting companies purchase 90% or more of their total power needs. Twenty per cent purchase less than 15%. Among the 28% who generate significant amounts of power, typical generating capacities range from 10 to 40 Mva.

58% of the companies own their main substations. Another 13% either own part of the substation capacity or share ownership with the utility. Of the 60 companies reporting, four have no utility tie.



# INDUSTRIAL ELECTRICAL SYSTEMS

Electrical engineers in industry appear to be moving toward greater uniformity and standardization in power system design. Despite the wide variation in size of plant, type of product, and operating conditions, Electrical World's survey turned up many more similarities in practice than differences. While there were distinct differences in preference for some types of equipment, there was wide agreement in general design. The survey also revealed that in several aspects of design, large segments of industry are at variance with published recommendations.

Two-thirds of the industrials reporting were served by two or more utility feeders. In general, only the smaller companies relied on a single feeder. Exceptions were one large company with heavy in-plant generation and two companies in the 20- to 40-Mva range. However, only seven companies reported use of automatic throwover, with no discernible pattern by industry or size. Approximately 47% of the companies had more than one main substation.

Of the companies surveyed, 58% owned their own substations. Ownership was naturally lowest—45%—in industries with less than 5-Mva source capacity, and highest—70%—in companies with more than 50 Mva source capacity. Among the larger companies with utility-owned or joint substation, ownership appeared to be slightly lower in the paper industry, and in areas served by public power.

### 2.4-Kv Systems Decreasing

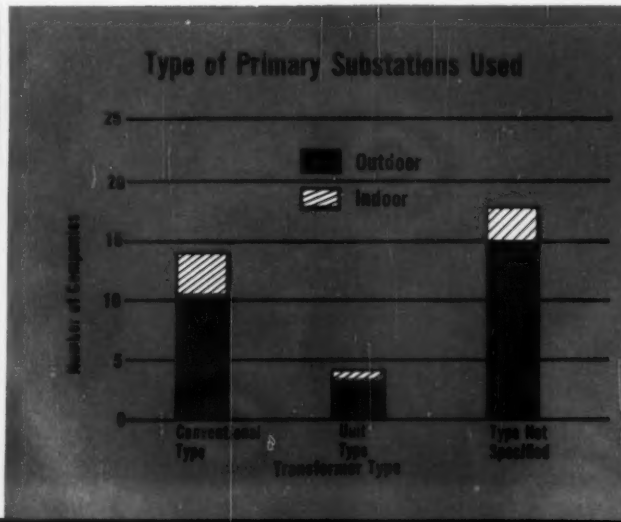
Approximately 70% of the respondents used a radial primary distribution system, 9% use a loop, and 5% a secondary selective system. The rest of the industrial plants use combinations of these three systems. The more complicated systems were more frequent in the larger plants and slightly more common in the chemical and petroleum industries. Secondary distribution systems were radial in 50 companies. Eight reported use of secondary networks.

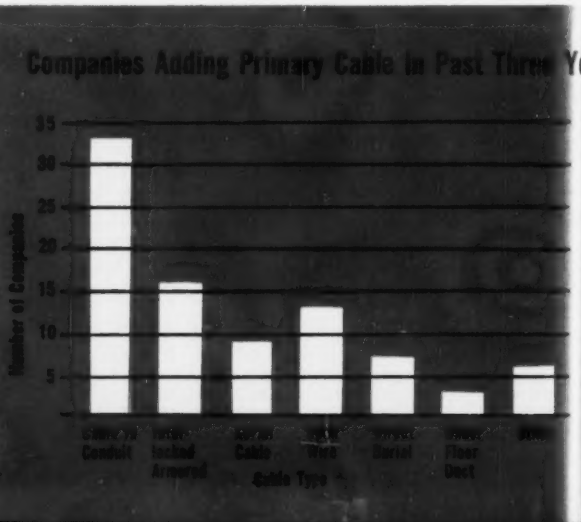
Standing out in the results was the apparent disparity between industry practice and the recommended primary voltages for various load sizes. For example, although both the AIEE Red Book and a majority of manufacturers suggest voltages in the 15-kv class for source capacities of greater than 20 Mva, 33% of the companies with such capacities report highest primary voltages of 4.16 kv or less, and 16% of 2.4 or less. Similarly, 50% of the companies in the 10- to 19-Mva class use voltages of 2.4 kv. Although individual circumstances may in many cases justify these apparently low primary voltages, it would appear that many industrial plants suffer from unnecessarily high losses and power costs.

One interesting aspect of the report was the decrease in the number of companies using 2.4 kv for a primary distribution voltage. At the present time, 13 companies or 22% of those reporting use this voltage for primary power distribution. However, the survey also revealed that six of the thirteen are planning increases in primary distribution, in most cases to voltages in the 13-kv range. Of these, two had source capacities between 20 and 50 Mva, two between 10 and 19 Mva, and two 5 Mva or less.

Although 23% of the companies have had or will have changes in primary distribution, only 15% reported changes in secondary power circuits, an indication that a substantial number of industries now modernize or expand by superimposing a higher voltage on the existing system. Only two companies reported changes in d-c voltage.

One of the surprising results of the survey was the large number of companies, 92%, reporting addition of significant amounts of primary distribution cable in the last three years. Of equal interest were the relative popularity of the various types installed. Thus 56% of the respondents reported installations of cable in conduit, compared to 28% installing interlocked armored cable. Similarly, 23% added open wire overhead, while 16% added aerial cable. Only 13% had installed direct burial cable.



The survey results also pointed up the move toward unit type secondary substations. Asked to specify the number and type of secondary substations—i.e., unit or field-assembled—25% of the respondents reported using only unit-type substations and 25% only field-assembled. Of the 21 companies using both types, ten reported more unit than field-assembled substation and eight more field-assembled substations than unit-type.

However, since many of the plants involved were in existence before the advent of unit-type substations, it may be assumed that a majority of the equipment installed in recent years was unit-type.

On an industry basis, field-assembled substations were most common in the paper, basic metal, and metal-working industries. Unit-type equipment was strongest in the chemical industry, where more than 53% of the companies listed unit-type equipment as predominant.

Asked to indicate their preference for transformer coolant type in replacing or adding secondary substations, 32% specified oil-cooled only, 30% askarel-type only, and 13% dry only. Approximately 20% reported they would use two or more types, depending on the application.

### Askarel-type Popular in Chemical Plants

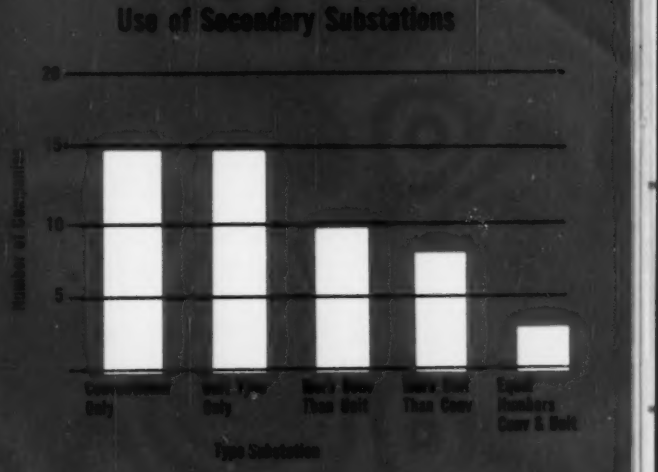
Broken down by industry, the askarel-type units made their best showing in the chemical and pharmaceutical industries, which represented 50% of the companies specifying askarel-type only. Dry-type transformers were preferred by all the glass companies reporting, either on an exclusive choice or as an alternate. Oil-cooled units were strongest in petroleum, oil, paper, and metals companies.

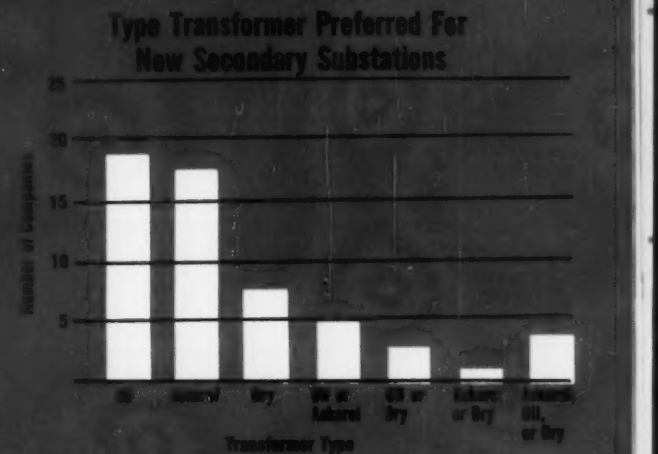
In response to questions about the type of protection use, 50% of the companies reported that incoming primary lines were equipped with relays and breakers. Fused disconnect switches were used in 10 cases and a combination of fused disconnects and breakers in four. Reclosers alone were used on three plants and a combination of reclosers and breakers in three others. Two companies reported a combination of breakers and fused load interrupter switches for incoming line protection.

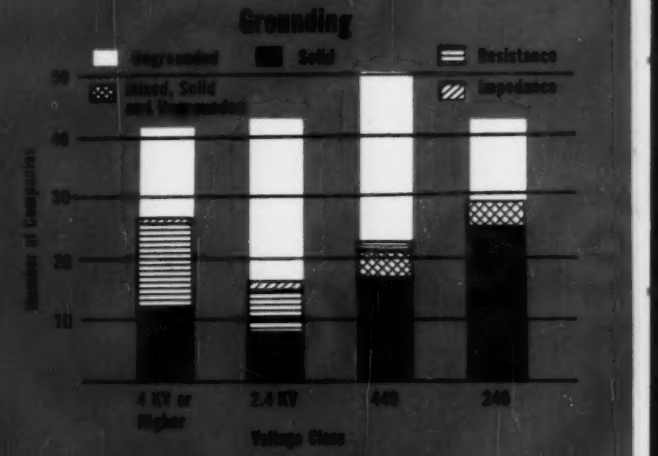
Secondary protection power was more clear cut, with 71% using breakers, and 13% a combination of fuses and breakers. Five companies protect lower voltage circuits with fuses alone.

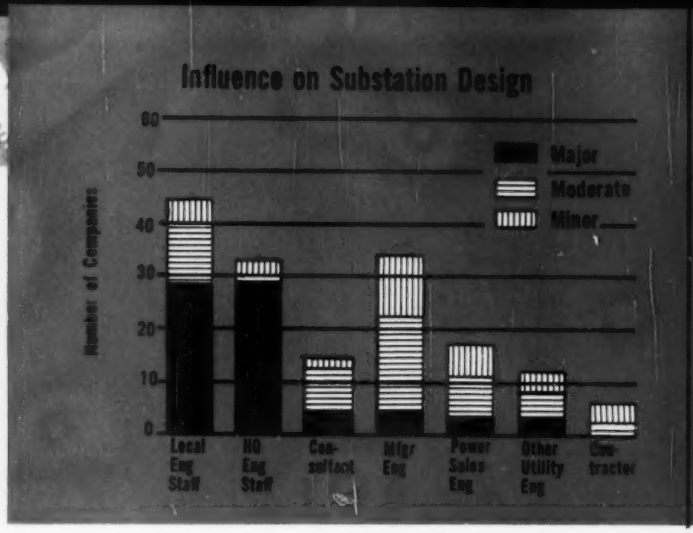
Grounding practices was another area where general industry practice appeared to vary greatly. Fully 25% reported ungrounded circuits of 4 kv or above. Local operating preference appeared to be the decisive factor, since no pattern by industry or by batch-vs-continuous process was discernible.

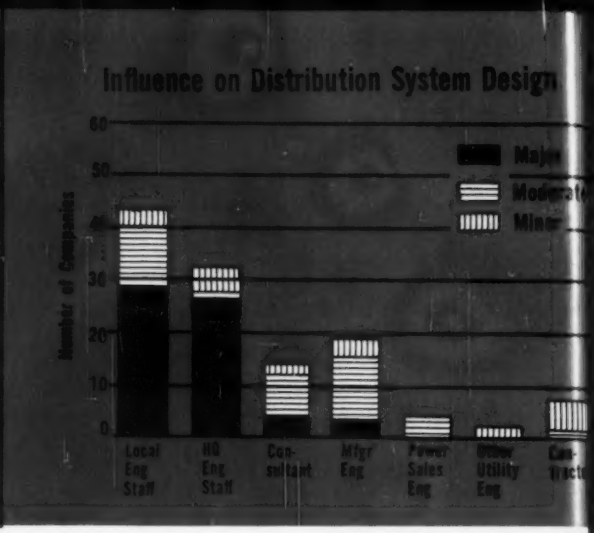
Systems of 2.4 kv are operated ungrounded in approximately 46% of the respondents' plants. Here again, local preference seemed to be critical although ungrounded systems were slightly more common in chemical plants than in other industries. In general, grounded systems operated at 2.4 or 4 kv were usually resistance grounded, while solid grounding predominated at lower voltages.






# Industrial Distribution System Design is

One purpose of the survey was to determine how much of the industrial system design was done directly by the industrial electrical engineer and to what extent he is influenced by outside engineering groups—consultants, manufacturers' engineers, utility engineers, and contractors.

Respondents were asked to indicate the degree of influence—major, moderate, minor, or none—exerted by these outside groups, by local plant engineers, and headquarters staffs on major system changes, on the purchase of power equipment, and on six specific design jobs.

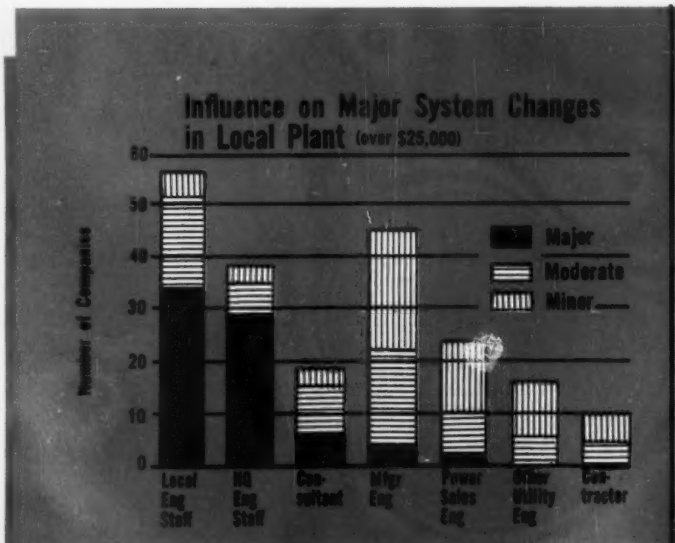
Participation in the six design jobs is shown by the charts at the top of this page and on the next page. Influence on major system changes and on equipment purchase is shown below. In interpreting the charts, it should be noted that 16% of the responses were essentially one-plant operations, with no "centralized engineering staff." Similarly, approximately 20% purchase less than 15% of their power.

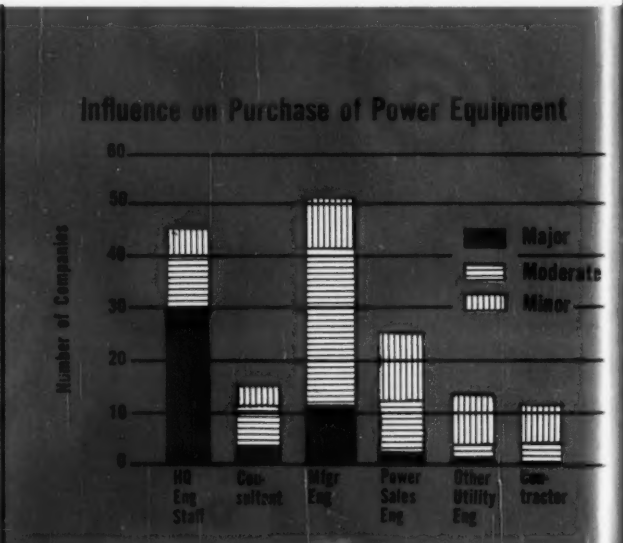
To simplify comparison of the influence exerted by each group, an index system with arbitrary values for each degree of influence was set up. Each group was given five points for every mention as a major influence, three points for moderate influence, and one point for minor influence. Based on this "point system", the table below provides a rough but quick index to the relative influence exerted.

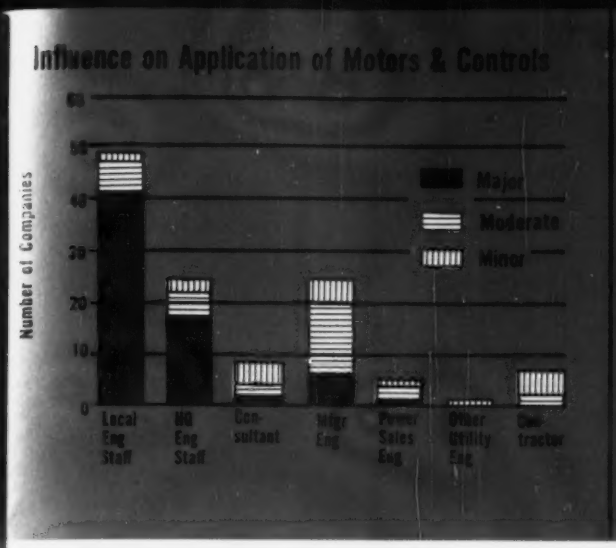
| | Loc Eng | HQ Eng | Mfg Eng | Util Eng | Con- slt | Con- trtr |
|---|---|---|---|---|---|---|
| Major System Changes | 266 | 166 | 95 | 73 | 63 | 18 |
| Purchase of Equip | * | 185 | 155 | 74 | 43 | 19 |
| Substation Design | 188 | 151 | 86 | 79 | 46 | 12 |
| Dist System Design | 179 | 138 | 55 | 14 | 46 | 10 |
| Select. Syst Voltage | 193 | 145 | 51 | 50 | 33 | 7 |
| Coord Fuse & Relays | 177 | 113 | 82 | 44 | 38 | 8 |
| Applic Motors & Control | 225 | 103 | 77 | 16 | 21 | 11 |
| Cable System Design | 189 | 127 | 77 | 13 | 33 | 16 |

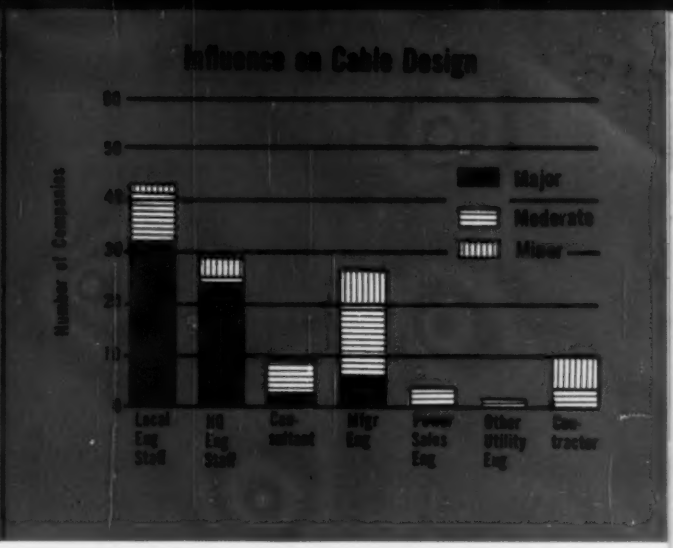
* Not included in question

The most obvious conclusion of the survey is that the major influence in all aspects of system






# Cooperative Effort

design is the industrial's own engineering staff, either in the local plant or a centralized engineering staff. Thus in only two cases was the influence of outside groups on major system changes reported as greater than that of company engineers. Similarly, only six reported an outside group as the principal influence on substation design, cable system design, or coordination of fuses and relays. For each of the other three design tasks, no more than three companies identified an outside engineering group as the principal influence.

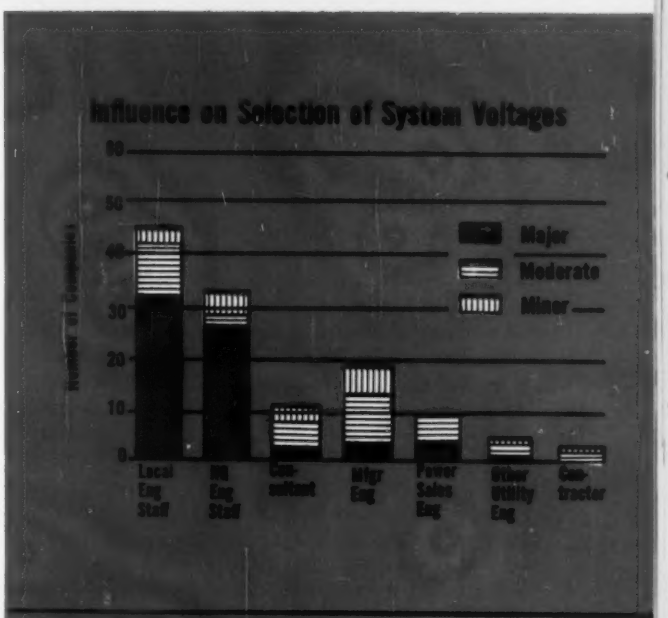
However, the survey results make it clear that outside engineering groups are a strong secondary influence on all aspects of system design. Major system changes are influenced by manufacturers' engineers in 75% of the plants, by utility engineers in 38%, and by consultants in 31%. There are, however, big variations in the degree of influence.

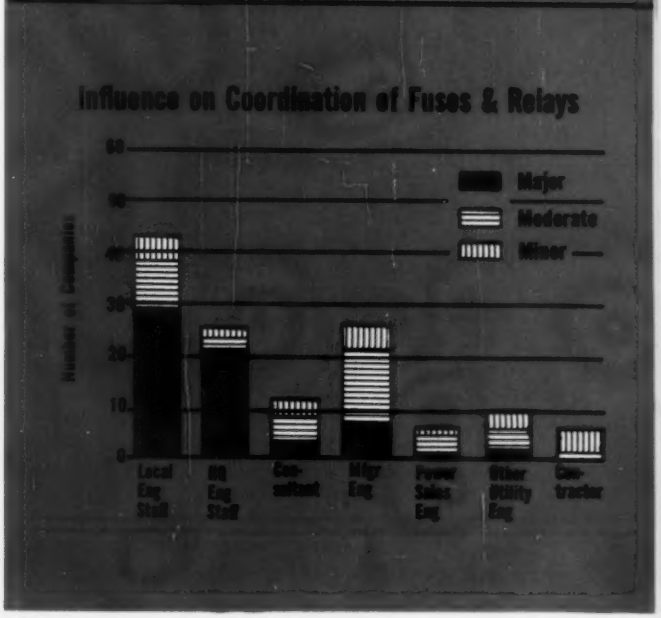
Strongest influence among the outsiders is the manufacturers' engineer. Compared to other outside groups, he made his strongest showing among the six design tasks in application of motors and controls, cable system design, and to a lesser extent, coordination of fuses and relays.

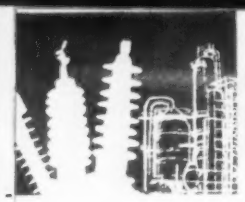
Taken as an aggregate, the utility engineer was second in line, running close behind the manufacturers' engineer in several areas. Approximately 48% of the industrials cited him as an influence in substation design, 43% in coordination of fuses and relays, of and 65% in major system changes. However, the results do indicate that a surprisingly large number of industrial electrical engineers fail to make maximum use of the utility's wide knowledge and experience in coordination of fuses and relays.

The consultant's heaviest influence, 32% was in major system changes. Weakest role was application of motors and controls, where only two companies listed him as a major influence.

Last on the list was the contractor, who was not considered as a major influence by any company. His best showing was in design of cable systems.





INDUSTRIAL
ELECTRICAL
SYSTEMS

# To Get the Best for Your Transformer Dollar... Take Another Look at Real Needs and Costs

**Total cost, including allowances for site, maintenance, accessories, and installation, must be balanced against process requirements, cabling runs and potential hazards.**

**Standard units simplify relay and breaker coordination, improve voltage regulation**

**F. D. KAISER**, Section Manager, Medium Power Transformer Engineering, Westinghouse Electric Corp, Sharon, Pa.

Significant savings in industrial distribution system cost and a comparable improvement in overall system operation can be obtained by judicious selection of transformers in secondary, primary, and main substations. Since transformers represent one of the largest single items in system cost, proper selection of type and design may, without any sacrifice in transformer quality or capacity, produce savings large enough to permit improvements in other aspects of the system.

To obtain the desired economy, the system designer must consider the total cost of each type of unit for each installation. Other factors which must be evaluated, in addition to the initial cost of the transformer, include:

- Anticipated maintenance, both for the transformer and the coolant
- Substation site, either land or floor space
- Accessories required, such as vaults, vents, and supporting structures
- Protection of plant, equipment and personnel from fire and explosion
- Effect of transformer design and type on system protection requirements
- Relationship between additional substation capacity and cable costs
- Effect of selection on service continuity and cost of lost production

One of the simplest methods of reducing substation cost is to use standard equipment. Many installations using non-standard substations exist, where a standard unit might have provided equal or better service at a lower cost.

Savings in delivery time and in first cost, resulting from mass production techniques, are generally recognized. But many system designers overlook the indirect savings and improvements in system efficiency resulting from use of standard equipment.

For example, the absence of zero sequence line-to-neutral current in the standard delta primary greatly simplifies the protective relaying required for the system. Coordination between breakers and fuses is much easier. The protection provided by the fused delta primary, both against secondary terminal shorts and internal winding failures is greatly increased. In addition to savings in the cost of the protective system and in maintenance required, the reliability of the system is improved and the possibility of costly production stoppages reduced.

### Wye Primary Not Necessary

Frequently system designers specify a wye-connected primary because they are served from a 4-wire utility system and believe that all four wires must be used. Actually, it is generally not required to use the fourth wire and the overall system may be improved through use of a 3-wire delta primary.

Use of non-standard impedances can also produce undesirable effects on system operation. If too high an impedance is chosen, voltage regulation on all circuits served by the transformer may be seriously impaired, making motor controls, instrumentation and furnace controls more vulnerable to voltage dips and other transients.

Using a transformer with too low an impedance will further complicate coordination between fuses and relays. The low impedance narrows the range of fuses that can be used and often forces the designer to choose between reduced transformer protection or more frequent replacement of fuses. In addition to the potential loss of valuable equipment and the greater maintenance cost, the possibility of system interruptions is also increased.

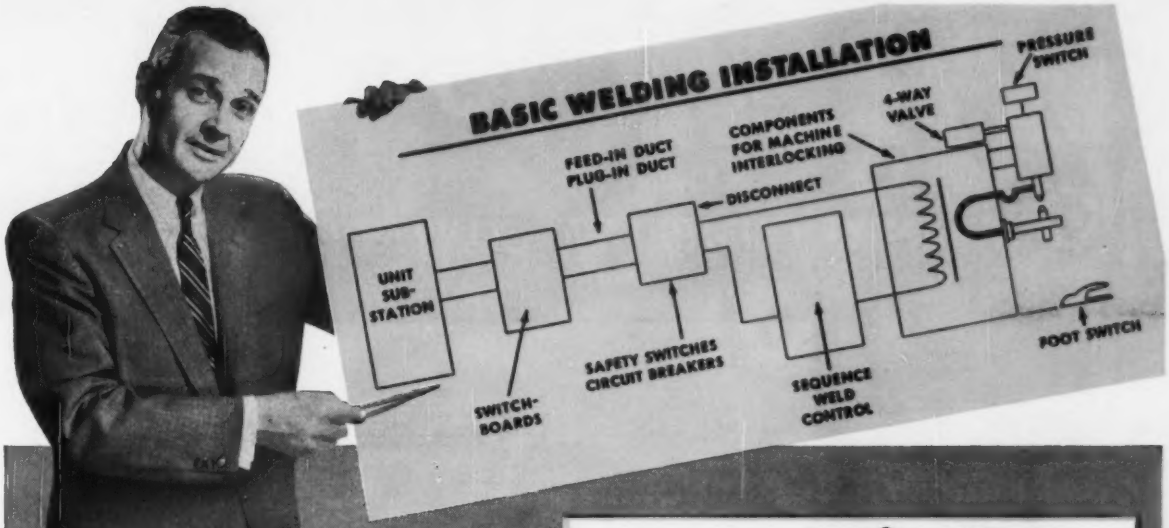
Occasionally system designers attempt to correct a poor system voltage by using transformers with non-standard taps. This is a poor substitute for improvement in the system itself.

### Standardized Units Facilitate Changes

Another economic advantage of the standardized unit is the greater flexability provided for system expansions or changes. When a standard unit is outgrown at one location, it can be more easily relocated or reused at another plant. Similarly, the resale value of standard units is significantly higher. Moreover, replacement or repair in time of emergency is much faster if standard equipment is used.

The economic advantages of load center distri-

(*Continued on page* 74)




# Here's the Easy Way

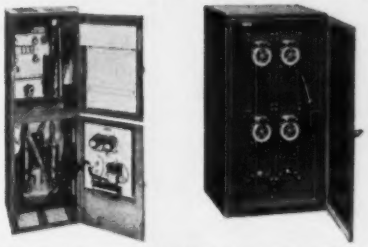
## TO A BETTER WELDING INSTALLATION

• Whether you start from scratch or expand an existing operation, your Square D Field Engineer has two important things to offer to make your job easier.

First, he has the background which enables him to offer sound counsel at the planning stage. Second, he is backed by a complete line of performance-proven electrical equipment with which to put practical planning into action.

Field Engineers are available through Square D branch offices in all principal United States cities—and in Canada, Mexico and England. Backing up these engineers are the design and manufacturing facilities of 14 strategically located Square D factories and the localized services of a nation-wide network of authorized electrical distributors.

### SQUARE D DOES THE *Complete* JOB!



ELECTRONIC and MAGNETIC WELDER CONTROL

SUBSTATIONS · SWITCHBOARDS · FEED-IN DUCT

PLUG-IN DUCT

SAFETY SWITCHES · LIMIT SWITCHES · PRESSURE SWITCHES · 4-WAY VALVES

PUSHBUTTONS · SELECTOR SWITCHES · CONTROL RELAYS · FOOT SWITCHES

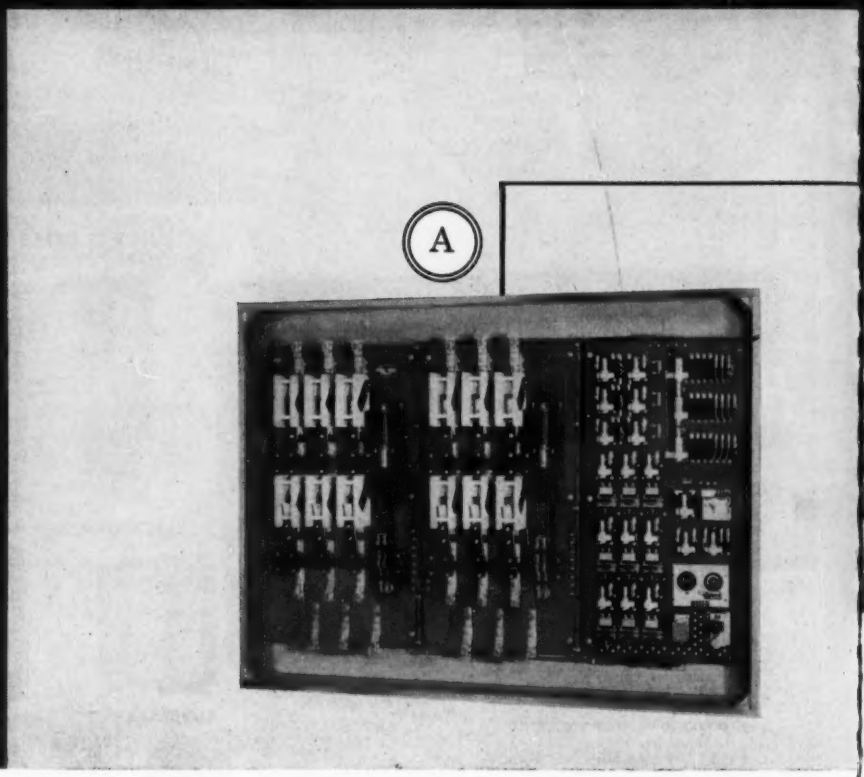
PILOT LIGHTS

**NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE**

**SQUARE D COMPANY**

# WHEN POWER

## *ASCO COMPLETE CONTROL SYSTEMS PUT S*




### *Here's how ASCO control system operates . . .*

ASCO Automatic Transfer Switches, with built in selected time delay of ½ to 3 seconds, ignore momentary outages caused by transient conditions—thus protect generating equipment from false starts. However, once a sustained outage is detected, ASCO Control Systems put standby power in action—fast. Follow the cycle, step by step . . .

**STEP 1** The instant a sustained outage is detected, a contact on the ASCO Automatic Transfer Switch (A) closes.

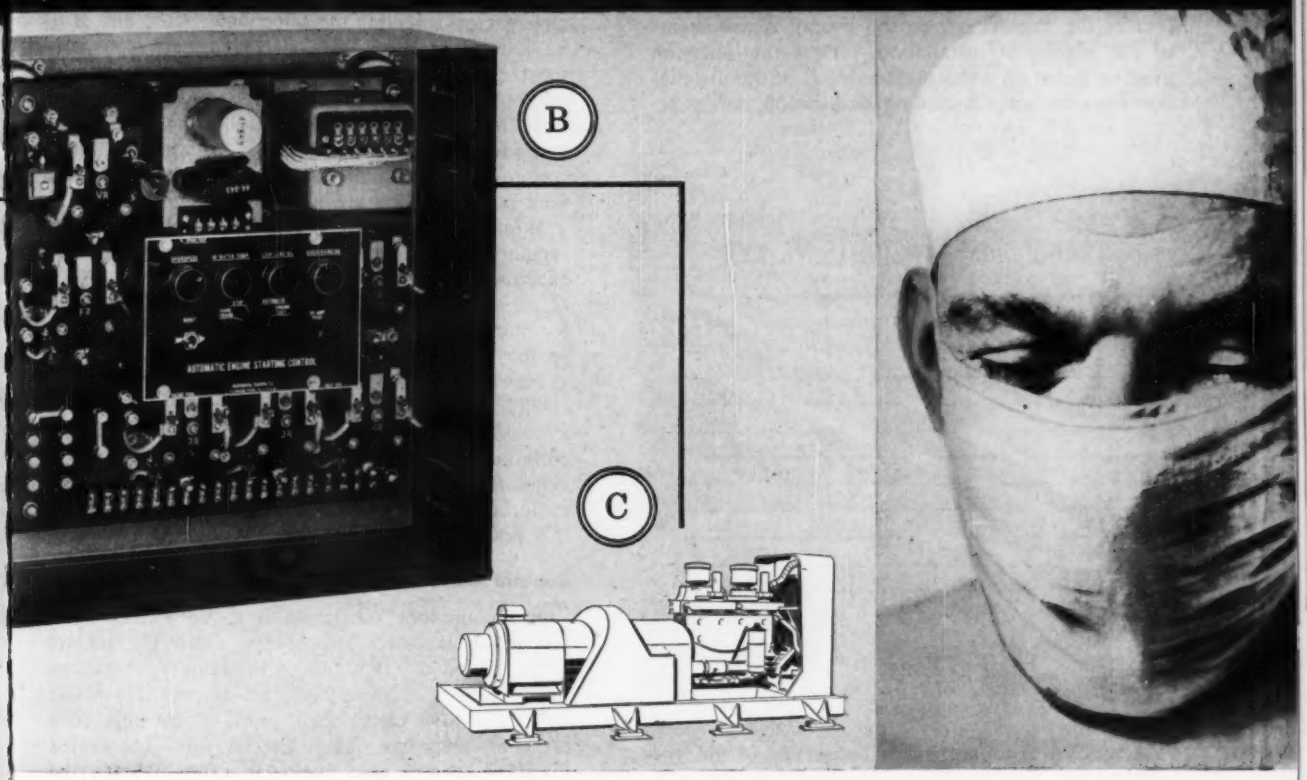
**STEP 2** This energizes the ASCO Automatic Engine Starting Control (B), which opens the fuel control device on the generator and cuts in batteries to energize the starting motor and crank the engine (C).

Four on-off cranking cycles are provided. When the engine fires, the starting control automatically disconnects the cranking control.

**STEP 3** When standby power source reaches proper voltage and frequency, the transfer switch transfers the load to the electric plant. Time of transfer—1/30 to 1/6 of a second!

When normal power is restored, the ASCO Transfer Switch returns the load to its original feeder lines. The Starting Control then causes the electric plant to shut down.

# STANDBY POWER IN ACTION – FAST




*For Dependable Standby Power,* ASCO designs and manufactures a complete line of emergency power and electric plant control equipment. In addition to Automatic Transfer Switches and Automatic Engine Starting Controls, this includes:

*Solenoid Valves:* For air starting applications, and for controlling the flow of cooling water, fuel oil and other liquids and gases.

*Battery Chargers:* To keep starting batteries charged, ready for engine starting.

*Solenoids:* For fuel control devices, operating shutters for engine cooling, and other electric plant applications.

*Load Demand Controls:* To automatically start engine when load is applied; stop it when load is removed.

*For Detailed Information write for:*

Catalog 57-S1 – Automatic Transfer Switches

Catalog 57-S5 – Solenoids

Catalog 57-S6 – Electric Plant Controls (including battery chargers)

Catalog No. 25 – Solenoid Valves

*Dependable control by ASCO*

## Automatic Switch Co.

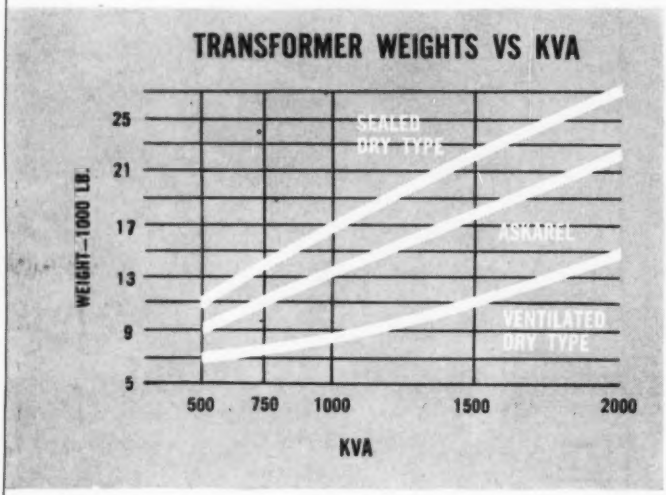
50-P Hanover Road, Florham Park, New Jersey • Frontier 7-4600

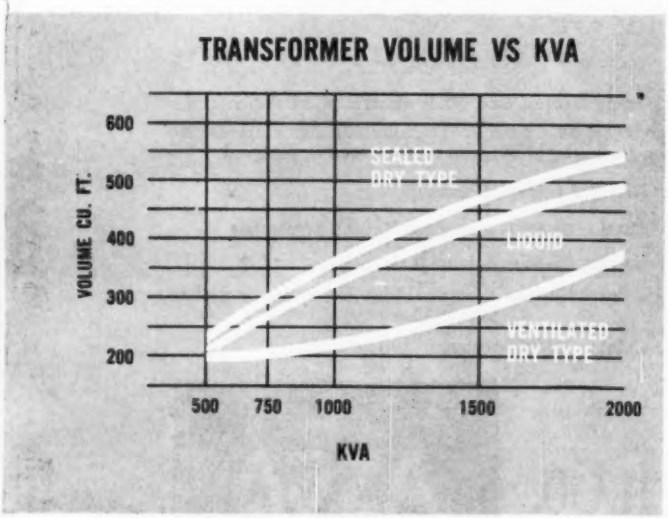
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

bution are generally recognized by most industrial system designers today. Size of the units and the substation arrangement are usually dictated by individual load characteristics. Thus the other principal area where significant economies can be realized is in selecting the type of transformer.

The key to economy here is to match the overall cost of the transformer to the overall requirements of the individual installation. Thus the selection must be based on a thorough analysis of the installation requirements—including its location, safety requirements, and distance from the load to be served —plus the total cost of each type for the particular installation in question. Factored into the total cost figure should be allowances for space, maintenance, vaults or supporting structures and, of course, the initial cost of the transformer itself.




Location of the transformer is one of the principal factors affecting the selection. If the unit is to be located outdoors, an oil-cooled unit is usually most economical. As indicated on the table, the oil-cooled unit has the lowest first cost. In an outdoor installation, the potential fire and explosion hazards of the oil-cooled unit are normally of minor consequence. Similarly, weight, volume, and base area considerations are not usually significant.

While the transformer and the oil both require regular maintenance, these requirements are not exceptional for an oil-cooled unit. Qualitative tests of oil are relatively simple and numerous facilities for more thorough tests are widely available through testing services, manufacturers, and utilities.

However, if the transformer site is not readily accessible or if capable maintenance personnel are not available, the sealed dry type unit may be worth considering, despite its higher initial cost. If a ventilated dry type is installed outdoors, it must be enclosed in a weather-proof housing. Consequently, it is not normally economical for outdoor use.

### Coolant Maintenance May Be Decisive

If the outdoor substation is to be located in a potentially explosive atmosphere, either the askarel or the sealed dry type unit is preferable. Although the first costs of these units are respectively about 20% and 40% higher than an oil-cooled unit, both are completely free of any fire hazard. The sealed dry type unit is also explosion proof. Since the gases produced by electric arcing in askarel are toxic but not explosive, there is no danger of secondary explosions. However, if the gases build up pressure in a completely sealed tanks, primary explosions can occur. For this reason, a pressure relieving device is required on askarel units of 25 kva or above.

Askarel units have one other disadvantage in that askarels are more sensitive to contamination by moisture and other impurities than oil-cooled units. In addition maintenance of askarel coolant requires special equipment, care and training in handling. Cost of replacement is about seven times as high.

The most economical transformer for the majority of indoor installations is the ventilated dry type. Although its first cost is about 20% higher than that of an oil-cooled unit, savings in other expenses frequently outweigh the initial cost.

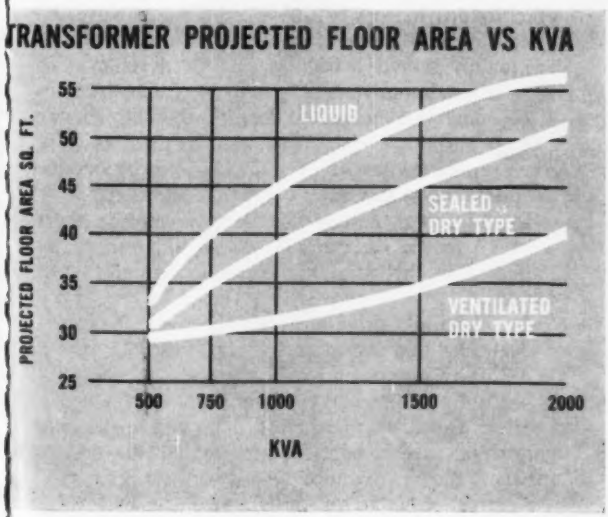
One of the principal savings effected with dry type transformers is the absence of coolant maintenance, which normally requires a significant ex-

## Comparison of Transformer Characteristics

| Type | Oil | Askarel | Ventilated Dry Type | Sealed Dry Type |
|---|---|---|---|---|
| Weight | 100 | 125 | 75 | 135 |
| Location | Outdoor or Vault | Indoor or Outdoor | Indoor | Indoor or Outdoor |
| First Cost | 100 | 120 | 120 | 144 |
| Fire Hazard | Potential | None | Low | None |
| Explosion Hazard | Primary and Secondary | Primary Only; Toxic Gas Possible | None | None |
| Maintenance | Normal | Above Normal | Below Normal | Almost None |

penditure of time and material in liquid-cooled transformers. Similarly, there are no gaskets to repair or replace, and no gauges to be maintained. As a consequence of the reduced maintenance, there is less possibility of production stoppages to permit scheduled or emergency maintenance of the transformer.

Unlike the oil-cooled unit, the dry type transformer has no explosion hazard and little or no fire hazard and can be installed indoors without the expense of a fire-proof vault. Where floor space is at a premium, the smaller base area of the dry types represents another saving in overall cost. Similarly, because of its light weight, the ventilated dry type can be readily installed on balconies or roofs, with a minimum of supporting structure. In addition, this frequently allows the transformer to be placed much closer to the load center, with a consequent saving in secondary cable cost, and an improvement in voltage regulation.




Since ventilated dry type transformers must have air passing through the windings to obtain cooling, they are vulnerable to corrosive fumes or excessive moisture or dirt. Where such conditions exist, either an askarel or sealed dry type transformer should be used. Here the choice will probably be between the lower cost and lower weight of the askarel unit, and the inherent safety and very low maintenance requirements of the sealed dry type.

Several performance factors are noteworthy in choosing between a liquid or dry type unit. Forced air cooling increases the capacity of a dry type unit to 133% of self-cooled rating. On a comparable liquid cooled unit, the forced air rating is 115% of the self-cooled capacity.

In the past the lower impulse strength of the dry type has made it more vulnerable to voltage surges than liquid-cooled equipment, particularly if the transformer is connected to exposed overhead lines by underground cables. However, the availability of dry type substations with built-in lightning arresters now provides the equivalent of a liquid-immersed transformer in surge voltage applications.

The standard sound levels of dry type transformers are traditionally higher than corresponding ratings of liquid immersed units. For most industrial applications sound level is not a factor; however it may be a serious problem in some applications. Recent improvements in sound level of dry type transformer have narrowed the differences between liquid and dry type units. In ratings of 500 kva and below, the dry type unit may be as quiet or quieter than the liquid unit.

# 4 Kv or 13 Kv . . . . Which Voltage for 10-Mva to 20-Mva Distribution Systems?

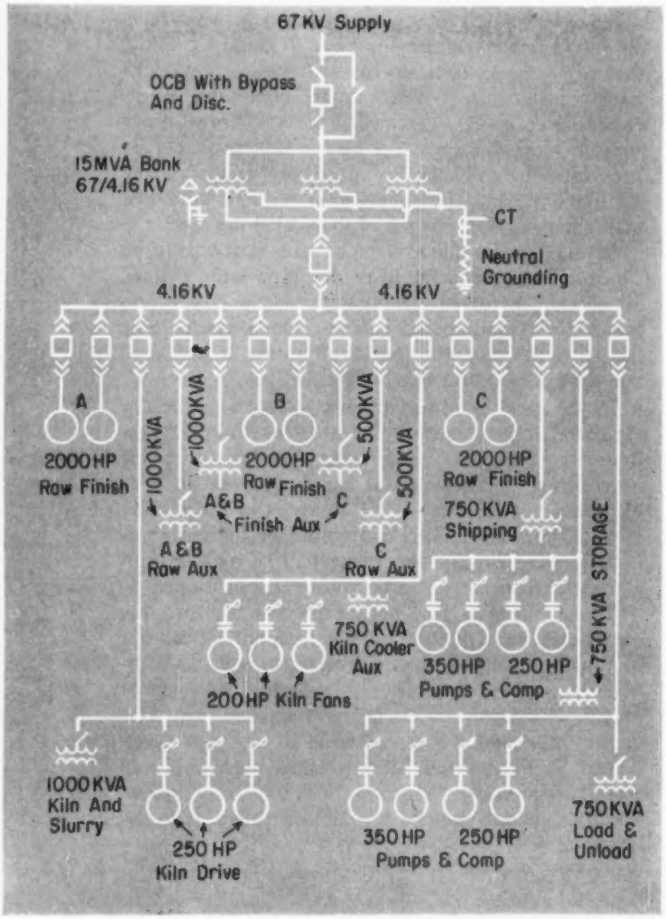
**W. A. B. MAXWELL** and **R. N. WILSON**, Switchgear Dept, Allis Chalmers Mfg Co, Milwaukee, Wis.

Selection of a primary distribution voltage for plants with a 10- to 20-Mva supply capacity is one of the industrial electrical design problems providing the most latitude for engineering judgment. Past experience and expert opinion indicate that 4.16 kv is usually most economic for systems below this range, and 13.8 kv or higher most practical for plants above 20 Mva.

However, in the "grey area" between these two limits the choice between these two voltages will depend on a number of other factors which must be individually evaluated for the particular plant in question: These factors include:

- Prospects for future load growth
- Load density in the plant as a whole and in specific areas
- Size and service requirements of the individual loads involved
- Class of service available from the utility or generators

The two following examples, representing two dissimilar types of industries, show how variation in these factors may influence the selection of the distribution voltage for plants in this range.




## CASE NO. 1: 4-Kv Found Best for 13-Mva Cement Plant

A 5-kv primary distribution sysem was found to be the more desirable for a recently completed wet process cement plant with a demand of 13 kva. Here the first cost of the two systems was the deciding factor, since no plant expansion was forseen. Moreover, the momentary and interrupting duty on the primary switchgear was within the capacity of both 5-kv and 15-kv apparatus.

The largest portion of the load was six 2,000-hp synchronous motors, which were used to drive the three raw and three finish mills. These could be adequately served at either 13.8 or 4.16 kv. To provide maximum versatility to meet cyclic variations in seasonal demand and economic conditions, the 12,000 barrel per day plant was designed to have three separate kilns. This assured a more economic operation when less daily output was needed.

In addition to the large synchronous motors, there were 14 motors in the 200- to 350-hp range. As indicated in the adjoining one-line diagram, these included:

3-250-hp kiln drive motors
3-200-hp kiln fan motors
4-350-hp pumps and compressors
4-250-hp pumps and compressors.

Here again, standard cost data and experience gained in similar construction limited the service for these motors to either 13.8 kv or 4.16 kv.

The rest of the motors, ranging from ½ to 150 hp, were distributed relatively homogenously through-

(*Continued on page* 81)

G&W

# POTHEADS

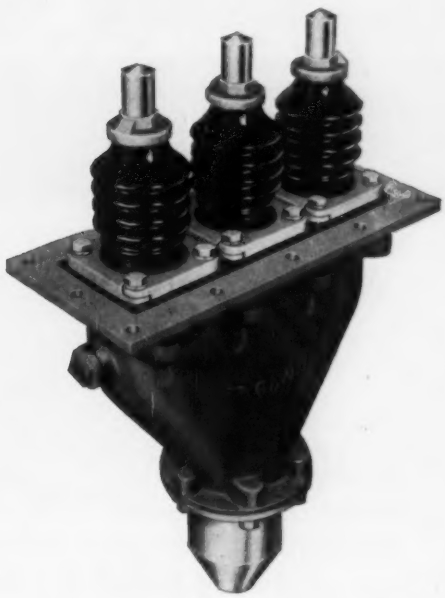
A581

## A DESIGN FOR EVERY CABLE

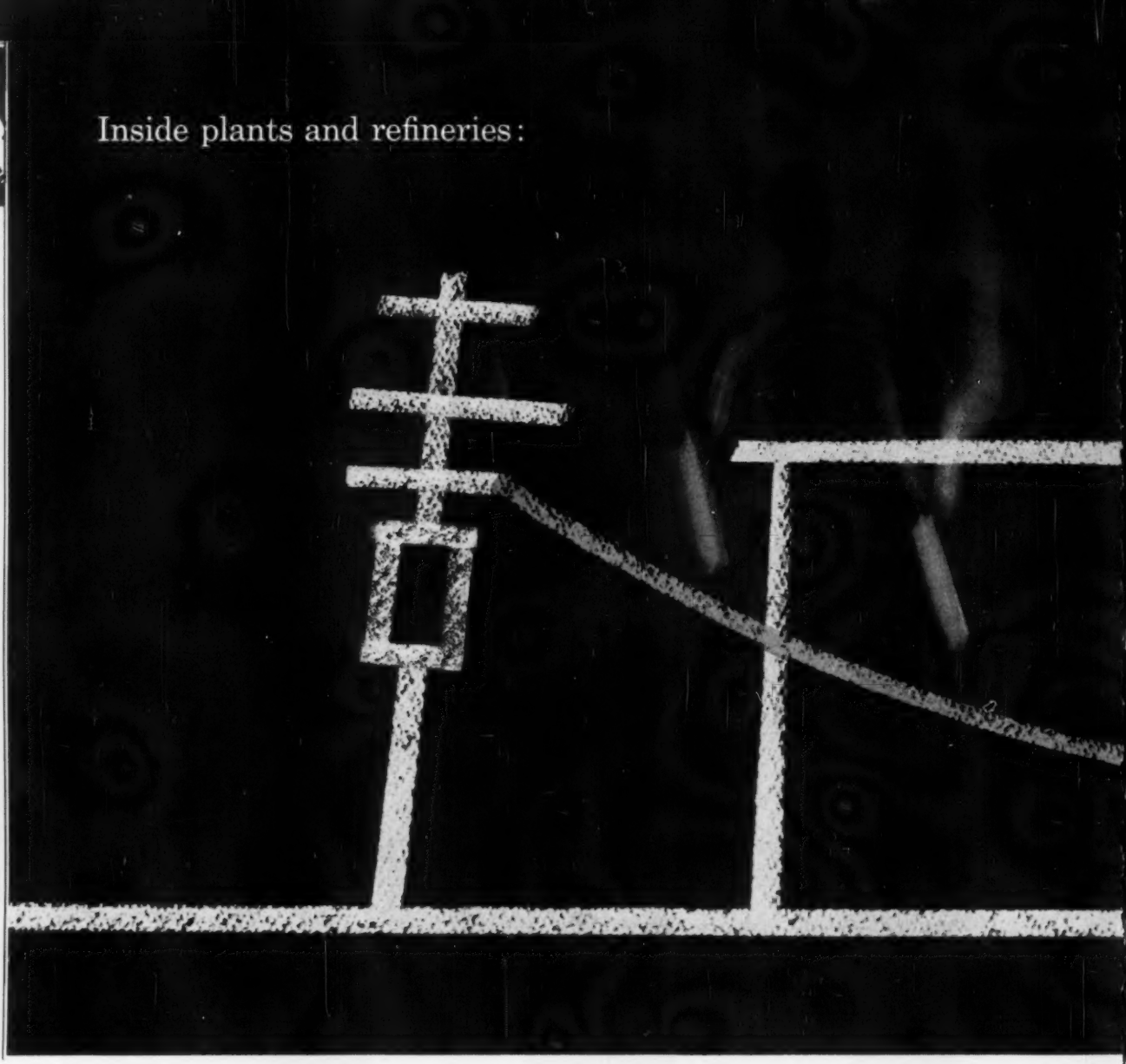
Only G&W can supply a complete pothead line—extra high voltage, capnut, soldered porcelain or disconnect—230,000 to 600 volts. High, medium and low pressure. Compound, oil and gas filled. Outdoor, indoor and for equipment mounting.

Specify G&W potheads for your cable terminations to be sure that potheads are available for every application.

**G&W ELECTRIC SPECIALTY CO.**
3500 WEST 127TH ST. • BLUE ISLAND, ILL.



Inside plants and refineries:



# What can you do about moisture, oil or corrosives that attack your wiring?

One refinery actually tested the corrosion resistance of building wire *on the job:*

Regular TW . . . neoprene-covered . . . braided rubber-insulated . . . lead-covered . . . and *Rome Synthinol 901!*

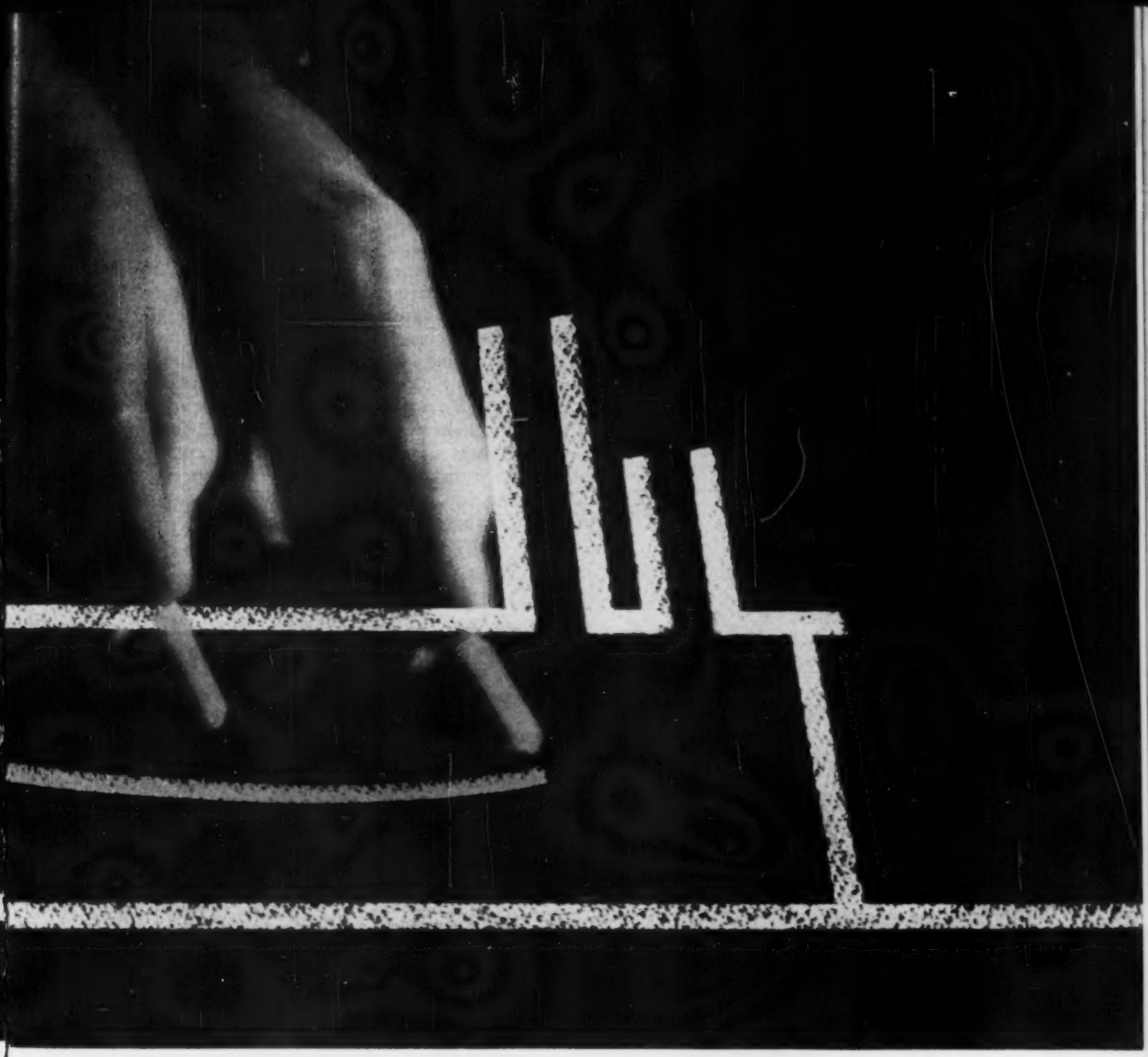
**RESULT:** Only Synthinol 901 and the lead-covered wire held up under exposure to corrosives.

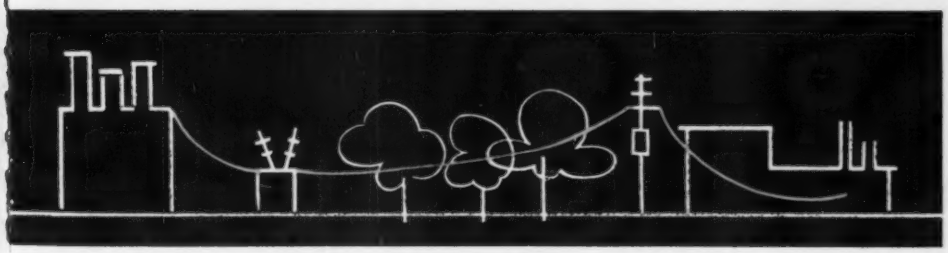
**BEST BUY:** Rome Synthinol—lower in cost and easier to handle than lead-covered wire.

Synthinol 901 has been proved in the lab and on the job for its resistance to moisture, oil and corrosive vapors. You can recommend it to your industrial customers for any low-voltage application—600 volts and under—including control circuits, plant and refinery equipment, and general wiring of office and warehouse buildings.

Where higher than normal heat conditions exist, you can recommend Synthinol 901 for its superior heat-deformation resistance. You can even use it to replace varnished cambric insulation on oil-filled transformer leads, where the leads are constantly immersed in hot oil.

Get further information, including lab test results, on Rome Synthinol 901—yours for the asking from Rome. Just clip the coupon, mail it today!





**Power source to plant**—Rome Cable gives you the *right* answer to every wiring problem. Power station to substation: Rome's interlocked armored cable "installs like cable, protects like conduit." Substation to plant or refinery: Rome's preassembled aerial cable goes up fast—even through trees—and is well protected from storms. Inside plant or refinery: Rome Synthinol gives maximum corrosion resistance, assures dependable service.

## ROME CABLE

**Department 1-8, Rome, N. Y.**

☐ Please send me more information on the above.

Name .....

Title .....

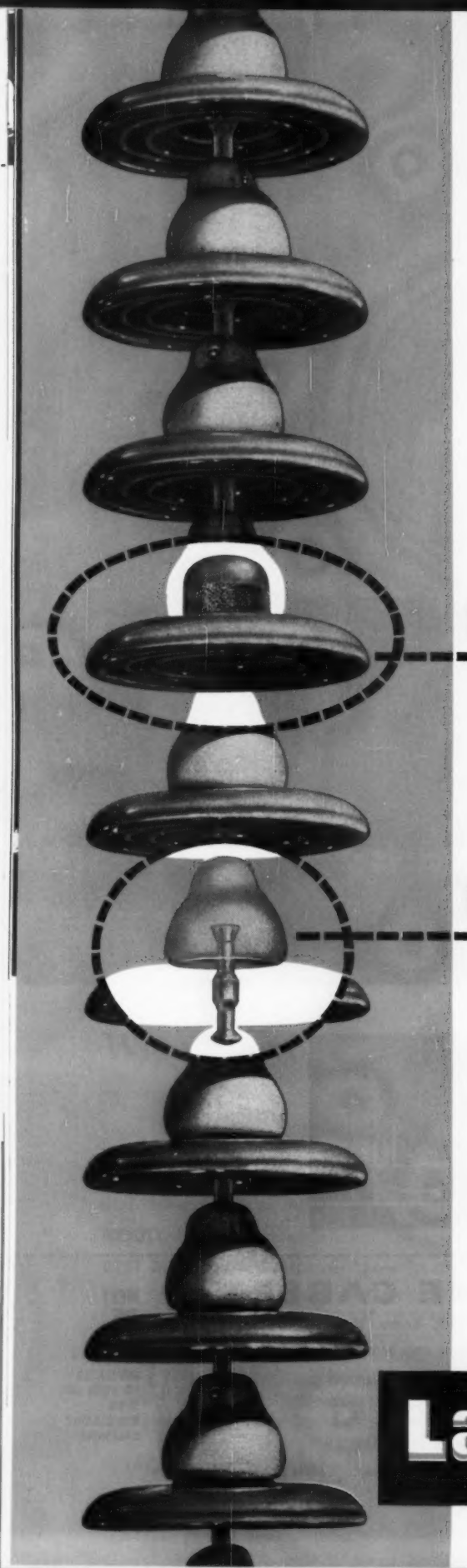
Company .....

Street .....

City ..... Zone ..... State .....

**MEET THE MAN**

WHO'S DEDICATED TO YOUR JOB YOUR ROME CABLE SALESMAN



## GOT AN INSULATOR CORROSION PROBLEM?

Competent transmission system design calls for selection of components matched to each other in useful-life-expectancy. It often is the case, in areas of salt spray and/or industrial contamination, that rusting out of suspension insulators may be the first sign of a line "wearing out"—years before conductors or structures are in need of replacement. For such lines now being constructed or planned, the need for high-line maintenance or future reinsulation—and its high cost in skilled labor, transportation, and materials—can be avoided. Lapp suspension insulators are available, on specification, with cap and bolt components in a variety of corrosion-resistant alloys. We now have a lot of test data and installation records to help us, and you, to predict performance of these metal parts over periods of varying conditions of weather, concentration of corrosive action, prevalence of contamination, leakage currents and corona. Ask your Lapp representative about it—or write direct to us.

## the porcelain is "forever"

Lapp vacuum process porcelain, with balanced compression-glaze "fit," has been proved—over millions of pieces, in thousands of shapes—the "most dependable insulation material on any system." Suspension discs are offered in standard (15,000-lb.) strength, high (25,000-lb.) strength, and heavy-duty shells. Fog-type units in same standard and high strength ratings, for either 5¾" or 6½" spacing.

## the hardware by specification

**FORGED STEEL** hot-dip galvanized, standard for caps and bolts. Smooth contours and uniformity of galvanizing have improved corrosion resistance over earlier insulators.

**MALLEABLE IRON** for caps only. Hot-dip galvanized, it is approximately equivalent to standard forged steel in corrosion resistance.

**LOW-ALLOY STEEL** hot-dip galvanized. For caps and bolts. Offers four to six times greater resistance to corrosion than forged steel. Nominal price premium.

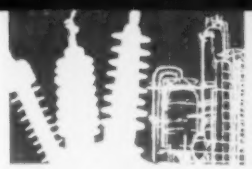
**DUCTILE NI-RESIST** for caps only. Considerably lower in cost than stainless, is second only to stainless in resistance to most forms of atmospheric corrosion.

**STAINLESS STEEL** has highest resistance to corrosion of any material. Used principally for bolts, can be furnished for caps where severity of operating conditions justify the cost.

**ALUMINUM-SILICON-BRONZE** for caps and bolts under special chemical atmospheres where its resistance exceeds that of stainless.

**Lapp**

Lapp Insulator Co., Inc., LeRoy, New York.





out the plant. These smaller motors would all be supplied at 440 v, regardless of the primary voltage selected. Consequently, no detailed consideration was given to them in selecting the primary.

Operating experience had established the advantages of the load center substation power distribution with a secondary voltage of 480/277, grounded neutral, and a straight radial distribution. To provide an emergency source of power for some of the raw and finish mill substation load in case of failure in the primary feeder or the substation transformer, a secondary cable was installed between the raw and finish mill auxiliary substations.

Since the total connected loads, demand factor, and diversity factor could be estimated quite closely, many of the associated problems were resolved with relative ease. These included determining: the maximum motor size to be served at 480 v; the number location, and size of the secondary substations; which motors would have separate air breakers and which would be fed from motor control centers; the number, location, and composition of the motor control centers.

A demand factor of 0.7 was used for the entire plant as well as for the component sections. To provide a little leeway for extra capacity in the future, a diversity factor 1.0 was used for the load center computations, in effect neglecting diversity in these components. For the main transformer bank computation, a diversity factor of 1.25 was used.

A demand kva of about 13,000 was indicated by the standard formulas. The next larger standard transformer 15,000 kva, was selected for the main substation. An economic comparison of the 13-kv and 4-kv primary distribution systems was then made.

If the primary distribution was to be 13 kv, additional transformation would be required for the 14 motors in the 200-hp to 350-hp range. These motors could be then served either at 4.16 kv or at 2.4 kv. It is not normally economical to serve motors in this range at 440 v.

### Relative Cost of Distribution Equipment

| | 4 Kv Pri Dist | 13.8 Kv Pri Distribution 4 Kv Motors | 2.4 Kv Motors |
|---|---|---|---|
| Load Center Substation Tsf. | 74.1 | 81.1 | 81.1 |
| High Capacity Starters | 116 | 116 | 104 |
| Induction Machines | 74.8 | 74.8 | 64 |
| Synchronous Machines | 193.5 | 302.4 | 302 |
| Switchgear | *135 | #158 | #158 |
| Power Transformers | 90 | 71 | 71 |
| Extra Transformers To Feed Induction Motors | ..... | 32.5 | 32.5 |

* 5-KV Apparatus  # 15-KV Apparatus

A comparison of the approximate costs of the major equipments is shown in the table above. Note that the cost of transformers is higher for the 4-kv distribution. Similarly, the cost of induction motors, and motor starters is higher for the 4-kv primary than for a 13-kv primary with induction motors served at 2.4 kv. However, the higher cost of load center substations and synchronous motors and the cost of additional transformation more than balance these savings.

Thus, estimated cost of the equipment shown in the one-line diagram, page 76, is in the order of $700,000 for the 4-kv distribution. With 13-kv distribution, estimates of total cost were $850,000 if the motors were served at 4.16 kv and $820,000 with motors served at 2.4 kv.

Since future expansion was not a consideration, the economic comparison was sufficient to justify the 5-kv class primary distribution voltage.

## CASE NO. 2: For New Quarry, 13.8 Kv Proves Most Economical

Lower first cost and more flexability for possible expansion made 13.8 kv the logical choice for a new limestone quarry with an 11-Mva demand and a 13-Mva peak. An economic study of the costs of serving 38 motors, ranging from 125 hp to 550 hp, indicated that a saving of about $30,000 would be obtained by using the 13.8-kv distribution. In addition, the higher interrupting capacities available with 15-kv breakers would permit future expansion without using the split bus and normally open tie breaker that would be required with 5-kv equipment.

Power could be obtained at 13.8 kv from a nearby utility line which had sufficient capacity to furnish a plant load of up to 35 Mva. If primary power was

### Relative Cost of Distribution Equipment

| | 13.8 Kv Dist 2.4 Kv Motors | 4 Kv Dist 4 Kv Motors |
|---|---|---|
| Primary Substation | | |
| 12/15 MVA Tsf, OA/FFA, 13.2/4.16 KV | ..... | 50.5 |
| 15 KV Dead End Structure | ..... | 3.5 |
| 4.16 KV Indoor Switchgear | ..... | 54 |
| Primary Switchgear | 56 | ..... |
| Squirrel Cage Motors, Gen Purpose (24) | 147.5 | 178.4 |
| Wound Rotor Motors, Open (10) | 75.45 | 87.9 |
| Synchronous Motors (4) | 18.12 | 20 |
| Motor Starters | 265.95 | 290.65 |
| Cable | 58.3 | 65.4 |

distributed at 13.8 kv, a transformation would be required at the load areas. Thus the 38 motors could be served at 2.4 kv.

If primary power distribution was 4.16 kv, these motors would be served directly at the primary voltage and no transformation would be needed in the load areas. However, a main substation would be required to step the incoming power company voltage down from 13.8 to 4.16 kv.

Comparative costs of the major pieces of equipment for the two possible distribution voltages are shown in the table at the bottom of page 81. This data does not include labor costs. Total estimated costs for the 4.16-kv primary distribution were $800,000. Total estimated costs for 13.8 kv, with motors at 2.4 kv, were $770,000.

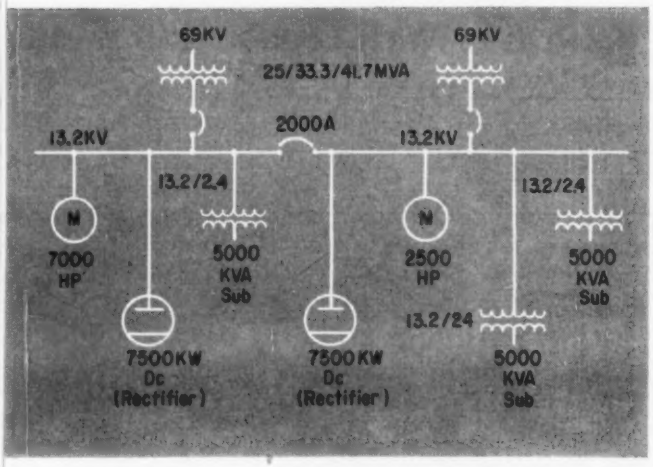
# Reliable 13-Kv Radial Scheme Powers Large Compressor Drives in Chemical Plant

**W. G. MURDOCK** and **W. E. SCHWARTZBURG**, Electrical Applications, Allis-Chalmers Mfg. Co, Milwaukee, Wis.

A simple radial system that combines good reliability for critical loads, simple coordination of protective devices, and full starting voltage for large motors is one of the features in a recent expansion of a large chemical company.

The design assures proper operation of a large, multi-stage compressor—driven by a 7,000-hp induction motor and operating in an explosive atmosphere—on which the success of the entire process depends. Other critical loads included 15,000 kw of mercury arc rectifiers and a 2,500-hp drive for a second compressor.

Since the total connected load was in excess of 40,000 kva, the utility supplying the plant tapped a 69-kv transmission line and furnished two 25/33.3/41.7-Mva stepdown transformers. Since the secondary current on these transformers was 1,830 amp at 13.2 kv, limitations in the current ratings of available circuit breakers precluded consideration of any lower distribution voltage.



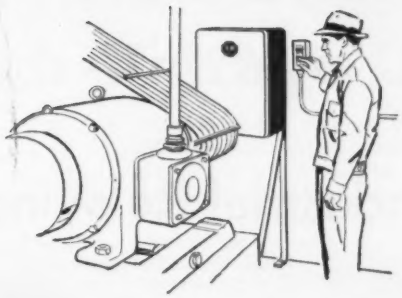

To assure maximum reliability, each transformer was throat-connected to a 2,000-amp, 15-kv metal-clad circuit breaker. Each breaker feeds a separate 13-kv bus. A normally closed breaker, rated 2,000 amp, connects the two buses.

Half of the rectifier load and the 7,000-hp compressor motor were connected to one bus; the rest of the rectifier load and the 2,500-hp motor were fed from the second bus. This arrangement proved very effective, since the 7,000-hp motor was designed for full voltage starting and its locked rotor kva inrush required a very stiff supply bus.

The rest of the connected plant load was supplied by three 5,000-kva multi-circuit substations. Two of these were connected to the bus feeding the 2,500-hp motor; the third was fed from the other bus.

The 5,000-kva substations stepped the 13.2-kv primary voltage down to 2.4 kv to supply the medium sized—i.e., up to 500 hp—motors. Motors smaller than this were connected to load center substations, one rated 750 kva and four rated 500 kva. Protection for the 2.4-kva motors was supplied by current limiting fuses and high interrupting capacity air contactors.

Initially, plant layout included a single air circuit breaker feeding a pair of load center substations. However, additional studies showed that an optimum arrangement would be obtained by feeding each load center substation through a starter unit comprising current limiting fuses and high capacity air contactors. The fuses provide short circuit protection. Overload protection is achieved by using conventional overcurrent relays in conjunction with the magnetically held contactors.

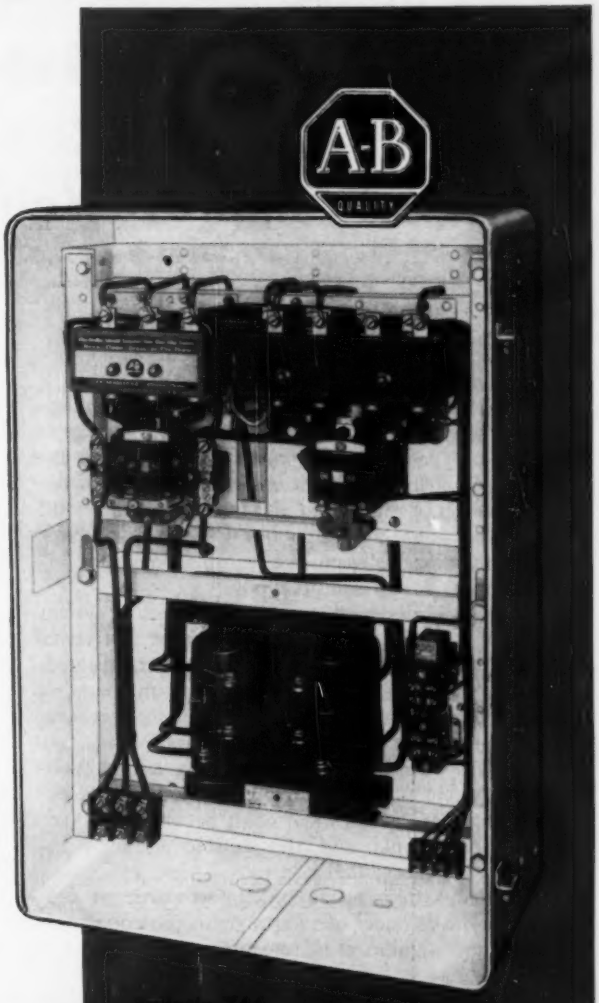


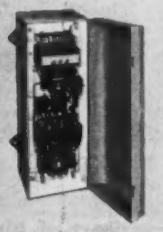
# WHEN REDUCED VOLTAGE STARTING IS A MUST

## Only Allen-Bradley can provide all the answers

The Allen-Bradley line of reduced voltage starters makes possible a selection of the best starter, not only to meet the power company's requirements but also to provide the best starting conditions for the motor and the "load" that it drives.

The simple solenoid contactors in A-B reduced voltage starters have only ONE moving part—assuring millions of trouble free operations. And their double break, silver alloy contacts never need costly maintenance. Accurate, reliable overload relays protect motors against burnouts. Write for Publication 6081.



**Bulletin 740**

Graphite disc resistors are automatically inserted in series with the squirrel cage motor at starting, and they are automatically cut out after a predetermined time. Turning a single screw on the starter frame adjusts the compression resistors exactly to motor and load conditions for velvet smooth acceleration. Ratings to 200 hp, 220-440-550 v.

**Bulletin 640**

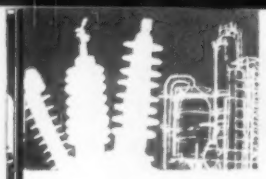
Where remote control is not needed, these graphite compression disc resistor starters provide stepless acceleration of squirrel cage motors. Operated by hand lever, the smooth starting of the motor is under the control of the operator. No-voltage and dependable overload protection is provided. Ratings to 200 hp, 220-440-550 v.

# ALLEN-BRADLEY

Member of NEMA

*Quality* Motor Control

Allen-Bradley Co., 1327 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



INDUSTRIAL
ELECTRICAL
SYSTEMS

# 19 Tips to Improve Your Industrial Relaying

**JOHN R. LINDERS**, General Supervisor, Relay Engineering Section, Cleveland Electric Illuminating Co, Cleveland, Ohio

Protective relaying is often the weakest component in an industrial power system. Although most industrial plants invest in modern protective equipment, many still do not get a full return in protection of personnel, equipment, or production facilities. Contributing to this inadequacy are improper coordination of the system and failure to understand the system aims and capabilities, because of poor communication between the various engineers involved in its design and operation.

A properly designed and tested protective system will pay for itself in reduced investment and fewer production stoppages. When properly interpreted, it will also accurately define the limits of operating prudence and provide guidance to both operating and maintenance personnel.

The responsibility for effectiveness of the protective system falls naturally on the industrial electrical engineer, as the focal point between his plant production people and the outside agencies involved with the system. In most cases, by careful analysis of system needs and a few pertinent precautions the engineer can improve his protective system without significant increment in cost.

## 1. Begin at the Beginning

The protective relaying function begins with the laying out of the one-line diagram. System protection is an integral part of the distribution system and must be designed into it from the start. If appropriate consideration is given to protection in designing the substation, selecting system voltages, designing the system grounding, and selecting breakers and fuses, the protective system can usually be simplified, its effectiveness improved, and its cost reduced. The cost of the protective system can often be more than offset by improved system design.

The number and location of breakers is a case in point. Breakers are adjuncts to the protective relays. If there is no protection requirement, load break disconnects could do the job more economically and with less maintenance.

Too often no consideration is given to protection until other aspects of the distribution system have been completed. Then the designer must try to remedy defects that are already built into the system. Frequently this is impossible. In any event, it leads to more complicated system protection and thus to a more expensive, less reliable system.

Starting early lets the engineer design protection from a system point of view, incorporating protection for individual components such as motors, transformers, and conductors into the overall protective scheme, rather than hoping individual component protection will somehow make a workable system.

## 2. Match Design to Process Needs

Early in the game, make a detailed study of service requirements for all loads. Determine which loads are interrelated by process requirements. Priorities for service continuity can then be established. By coordinating the relay plan and the one-line diagram, interrelated loads can then be dropped collectively during an emergency. This may permit continuation of vital services and minimize losses.

The cost of protection for any part of the system must be balanced against the probability of a fault there and the hazards and losses that would result from such a fault. However, it is unwise to leave any area completely unprotected simply because the fault probability is small or the consequences relatively minor. Any fault, no matter how minor, can conceivably snowball into a complete shutdown.

## 3. Pool Information and Efforts

By its very nature, the design of the protective system is influenced by outside agencies: utility engineers, manufacturers' engineers, consultants, and plant production engineers. Constant and close cooperation between all involved is necessary to assure maximum service continuity, effective coordination, uninterrupted production, and maximum economy. As the focal point of any such exchange, the industrial electrical engineer must be familiar with the problems and contributions of each group when the design is started. In laying out the protective system, he should consult operating personnel to work out the most desirable arrangement for routine abnormal system set-ups.

## 4. Make Operating Decisions Part of Plan

Occasionally there is a question of whether a relay should trip the breaker or merely sound an alarm. Such decisions should be part of the initial relay plan. In borderline cases, it is unfair to expect an operator to know what to do, while an emergency is developing, if the engineer can not make up his mind in the quiet calm of his own desk. In other words, when in doubt, trip.

## 5. Protect the Protective System

Before any detailed relay plans can be made, the system designer must recognize the possibility that

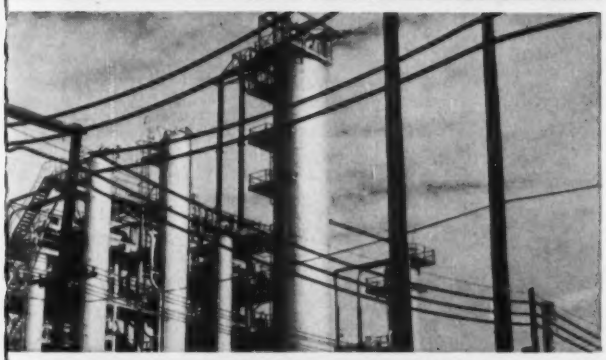
(*Continued on page* 87)

# How Okonite solves your High-Voltage Distribution Problem

Reliable primary distribution is a must for efficient, economical operation. As the use of higher voltages increases, the problems of keeping primary distribution reliable increase too. But, whatever your specific need, Okonite has designed a construction that will do the job . . . like those shown here.

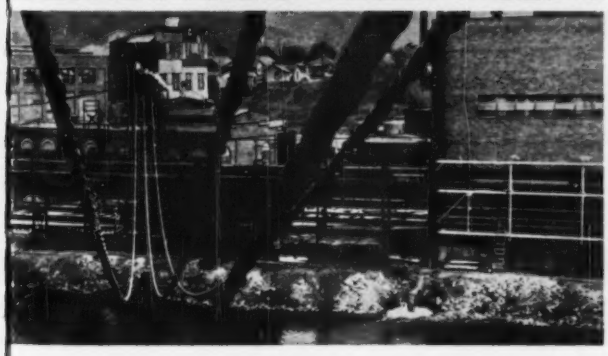
## OKOLITE-INSULATED

This Okolite-insulated 25kv submarine power cable, installed by Bonneville Power Administration under Puget Sound, was 7½ miles long, weighed ¾ million lbs. It is typical of the many Okolite-insulated cables designed to solve specific high voltage power problems. Other constructions for underground, aerial, duct or interior installation are frequently protected by an Okoprene (neoprene) sheath, compounded to Okonite's own formula for high weather, temperature and abrasion resistance. Okolite oil-base insulation has demonstrated in more than 30 years of service its high dielectric strength, moisture-resistance and stability in all types of installation conditions. All Okolite-insulated cables must withstand self-imposed a-c and d-c voltage tests that are highest in the industry.



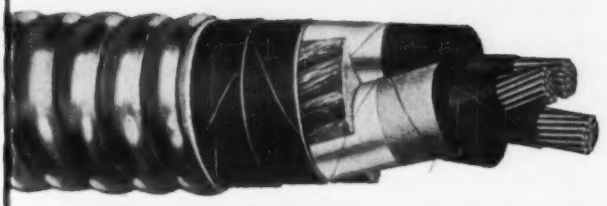
## OKONEX-OKOPRENE

This Okonex-Okoprene 15kv primary distribution system was installed to save space, eliminate safety problems and provide improved voltage regulation at Magnolia Petroleum's 1500-acre refinery near Beaumont, Texas. Okonex (butyl-base) cables are highly resistant to heat, and are often specified to give additional protection in high ambient parts of the plant or to provide additional ampacity in circuits. The Okoprene sheath provides excellent protection against moisture and corrosion as in Magnolia Petroleum's refinery where there was a high moisture-saline content in the air plus chemical atmospheres at many of the processing units.



## SELF-SUPPORTING CABLE

These four 7500-volt Okolite-Okoprene self-supporting aerial cables span 395 feet to distribute power to a section of a Southern paper mill. Easy to install in one simple operation, Okolite-Okoprene self-supporting aerial cable reduces clearance space requirements, is neat-appearing, often may be installed on existing buildings or supports, offers greater safety to personnel and eliminates insulator flashover due to contamination. Okonite's patented Dualay assembly can be tapped hot at any point in non-shielded types.



## LOXARMOR

And on any high-voltage construction, a Loxarmor covering offers economy and flexibility in a cable system where the complete protection of a rigid conduit system is not required. Excellent mechanical protection is provided by a Loxarmor interlocking "S" tape available in galvanized steel, aluminum, bronze or copper. Loxarmor saves money in installation and initial purchase costs, makes it easy to add or re-route circuits and requires less space than conduit to handle the same number of circuits.

One of these high-voltage cable constructions will fill your requirements. Write for Bulletin EW-1117, "How to Choose Insulated Cable," to The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, New Jersey.

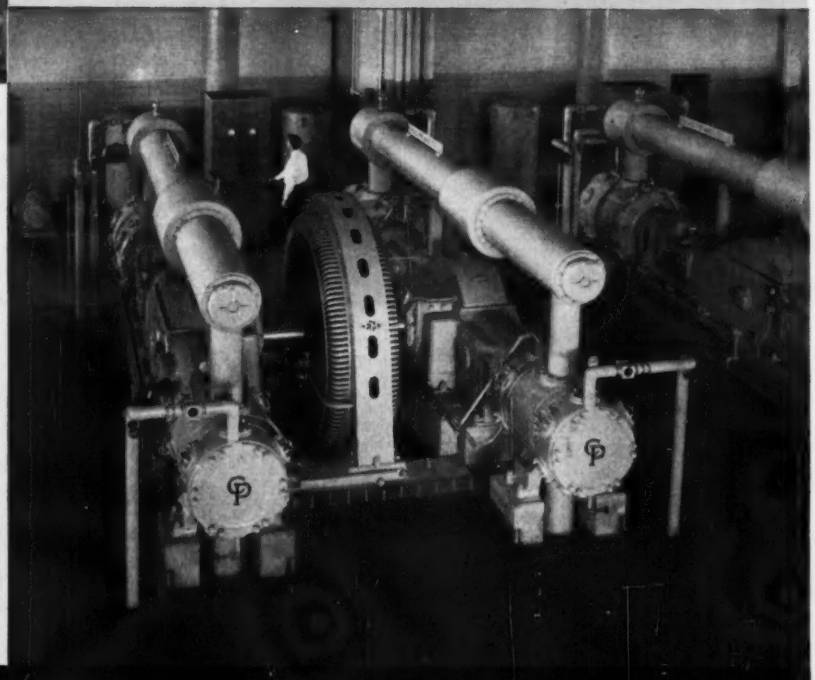
*where there's electrical power... there's* **OKONITE CABLE**

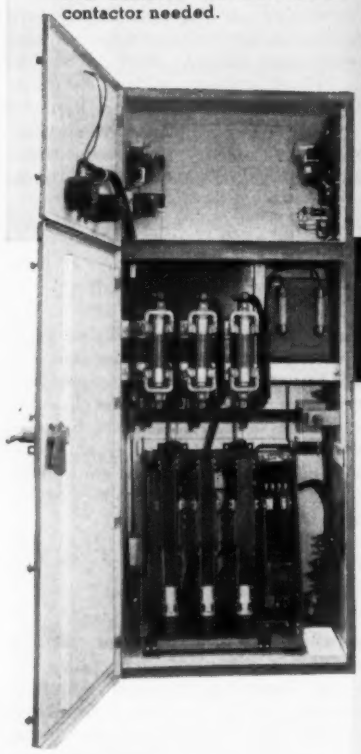
7090

# The most complete synchronous motor protection you can buy

*Above and at right* • Four EC&M 1000 HP, 2300 Volt Synchronous Starters on air-compressor drives in Chrysler Corporation's new Ohio Stamping Plant at Twinsburg. Purchased and installed by Hatfield Electric Co., Cleveland, Ohio.

*Below* • Inside view of starter showing compact arrangement of fuses and contactor. The three arc shields slide out for quick access to both front and rear contacts—no draw-out of contactor needed.





## EC&M 2200-4800 VOLT STARTERS

• A push of the "start" button gives you complete protection during starting and running—*plus* EC&M *fully automatic synchronization.* Throughout the entire sequence, motor windings are completely protected and synchronization occurs at the most favorable time. Should the motor pull out of step because of voltage dip or overload, the field is automatically removed. Re-synchronization occurs when the motor re-accelerates the load. Short circuit protection is provided by current-limiting power fuses working in conjunction with EC&M's *"certified"* high-interrupting-capacity ZHA air-break contactor.

For complete details...

***WRITE FOR BULLETIN 8210***

**THE ELECTRIC CONTROLLER & MFG. CO.**

*A DIVISION OF THE SQUARE D COMPANY*

**CLEVELAND 28 • OHIO**

8897

the protective system itself can fail to operate at a critical time, with catastrophic consequences. For example, the engineer should avoid using control fuses and other components which are common to both the primary and back-up protection.

### 6. Use Only Relays Enough to Do the Job

In addition to failing to operate when needed, a relay may also operate when it should not. Consequently, using extra relays to take care of anticipated malfunctioning of basic relays—because of poor maintenance—is poor policy. The designer should strive to use the minimum of relays that will do the job effectively. Each relay above the minimum is just one more possibility of an improper trip-out in an emergency. Simplicity is one of the best ways to develop reliability.

### 7. Don't Neglect Relay Power Supplies

The current and potential transformers that supply power to the protective system deserve the same consideration as the relays themselves. Here again, the minimum number of components that will do the job should be used. The only exception is that all CT's and PT's should be monitored, at least on a tong test basis.

High currents can produce CT inaccuracies,—due to excitation needs of the CT—resulting in distorted wave shapes and ratio errors. To minimize these conditions, the ratio selected should be such that, with maximum fault currents, the secondary current is no more than 100-150 amp and the burden two ohms or less.

In many installations where a high ratio is needed for relaying and a low ratio for metering, industrials use a low ratio CT for the metering supply, with an auxiliary transformer for the relays. More reliable protection is obtained by supplying the relaying directly from a high ratio CT, with an auxiliary transformer to supply metering. It is easier to predict performance under fault conditions for the high ratio CT than for the auxiliary transformer. In addition, in the first scheme, the auxiliary transformer is one more link that might fail to operate.

Potential transformers which are connected grounded wye must be fluxed for full line-to-line voltage to avoid blown fuses on overvoltages caused by line-to-ground faults.

All secondary instrument circuits should have one good protective ground. If multiple grounds are used, fault current may flow out of one ground, through the secondary wiring, and into the second ground. The high current may then destroy the instrument wiring and cause improper relay action.

### 8. Know What to Expect of Your System

Unfortunately, many industrial engineers are not familiar with the potentialities of their protective system. Frequently, they accept major outages as inevitable when recalibrating a few relays or some other small corrective action would either prevent or minimize them. Even when relay coordination is set up by a consultant or utility engineer, the industrial electrical engineer should know the proper settings and understand the reasoning behind them. At a minimum, he should be able to tell whether the protective system is performing the function it was designed to do.

### 9. Put It in Writing

A written record of the entire relay plan, coordination curves, proper relay settings, and the aims and capabilities of the system should be kept as an adjunct to the one-line diagram. Frequently, because of divided responsibilities for relay selection, installation, maintenance, and coordination, no one man is completely familiar with the system. Similarly, personnel transfers, promotions, or retirements may remove the one man familiar with the system. After a little time has passed even a well-informed engineer may forget many of the details.

### 10. Keep Other Plant Personnel Informed

In addition to his design function, the engineer is responsible for informing plant operating personnel in detail of the concepts of the system design and its limitations, particularly as they affect the relay plan. Conversely, the operating personnel should expect to receive this information.

### 11. Provide Sufficient Margin for Pick-up

Wherever possible, relays should be calibrated so there will be at least three times pick-up at the critical relay for a minimum fault condition. This apparently large safety factor is needed to take care of calculation errors caused by unknown factors in the fault impedances. In particular, machine characteristics and decrements are frequently not known in detail. Fault resistance is usually ignored in calculating fault currents, and other components may depart significantly from values in handbooks.

High resistance ground paths may also alter calculated ground fault current substantially. The threefold margin also allows for instrument transformer errors and variations in source impedance. When the utility is switching for routine maintenance, especially on weekends, the basic source impedance can vary widely, unknown to the industrial engineer.

### 12. Pick Coordination Method Carefully

Coordination can be developed in three basic ways:

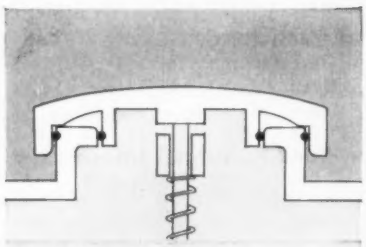
A. Restrictive Zone of Protection—The power system is defined into a number of overlapping zones of protection. One relay is used to provide first line-protection for each zone, whose limits are

(*Continued on page* 90)

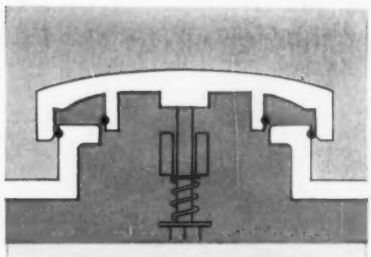
# Another Pennsylvania FIRST Ends Transformer Pressure Worries

## *Automatic Pressure-Relief Device Available as Standard Equipment*

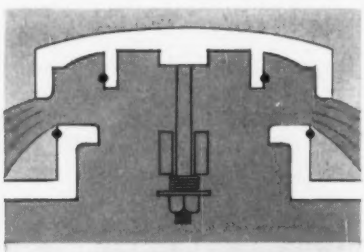
By JOHN KOEPKE
Mechanical Engineer



**HERE'S HOW IT WORKS:**
**1. Pressure-relief device remains closed with normal pressure in the transformer.**



**2. Overpressure breaks the inside seal . . . extending the pressure area to the outside seal, and accelerating opening.**



**3. Device is fully open and exhausting gas.**

### WHY A PRESSURE-RELIEF DEVICE?

Uncontrolled pressures are a potential source of trouble in everything from cooking pots to jet airplanes. Down through the years many kinds of diaphragms and non-resetting relief devices have been used to get rid of potentially dangerous pressures in transformers. None was entirely satisfactory. Diaphragms required replacement. Other relief mechanisms had to be reset. With some designs no one knew for certain at what exact pressure the device would operate. In addition, *all* of the non-resealing mechanisms left the transformer open to possible contamination.

With these problems in mind, Pennsylvania Transformer engineers set out to develop a design so basically simple and yet so dependable that it could be counted on to open *and* close *automatically* whenever needed—whether at frequent intervals or after many years.

### TESTS TOLD THE STORY

Since relief of sudden high pressures requires fast opening to a large exhaust area, the Pennsylvania design was proof-tested in a high-pressure tank using gas explosions with controlled rates of rise varying from 50 to *3080* psi per second. Even with a relatively low rate of rise, less than 300 psi per second, it took only eight thousandths of a second for the relief valve to fully open after the preset pressure was reached. Other tests revealed that it is the total size of the exhaust area that primarily controls maximum internal pressure. *This area in the Pennsylvania relief*

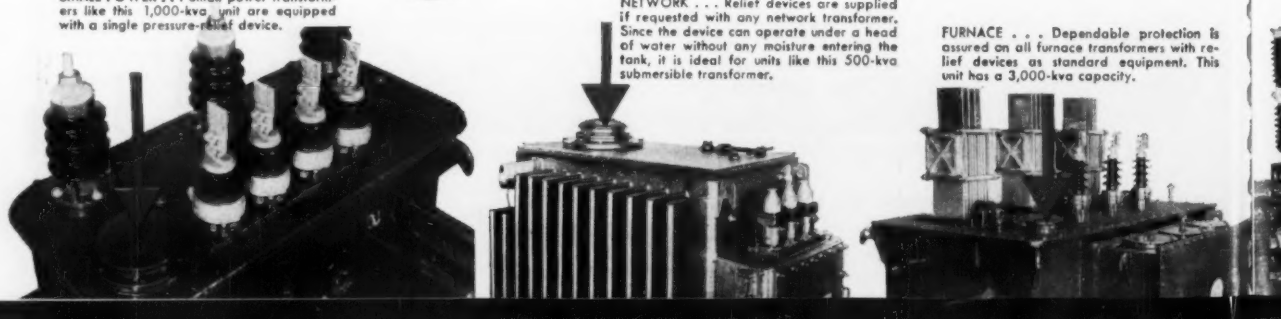
PENNSYLVANIA TRANSFORMERS

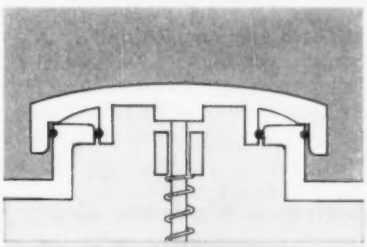
**PENNSYLVANIA**

SMALL POWER . . . Small power transformers like this 1,000-kva unit are equipped with a single pressure-relief device.

NETWORK . . . Relief devices are supplied if requested with any network transformer. Since the device can operate under a head of water without any moisture entering the tank, it is ideal for units like this 500-kva submersible transformer.

FURNACE . . . Dependable protection is assured on all furnace transformers with relief devices as standard equipment. This unit has a 3,000-kva capacity.





**4. Valve is reclosed against positive pressure.**

*device is substantially larger than that of competitive designs.*

## BOOSTER ACTION HELPS DO THE JOB

When operation occurs, pressure first breaks the main inner seal by moving the valve head only five percent of its total stroke. The area to the outer seal is then exposed to pressure, doubling the opening force and resulting in an extra accelerating kick.

Closure of the relief device occurs automatically before any air is sucked into the transformer where it could produce a secondary explosion. A powerful spring overcomes the force of the gas being exhausted from the tank and reseals the cover while a low gas pressure remains inside the tank.

## SURE TRIGGERING ESSENTIAL FOR DEPENDABLE OPERATION

Every Pennsylvania pressure-relief valve will operate within one-half psi of its calibrated setting. Pressure variations due to load changes in the transformer cannot prematurely trigger the device. Operation is controlled solely by a compressed spring held by a nut which is riveted to the shaft at the proper setting. This setting cannot be readily tampered with, and should the relief device be dismantled in the field, the design assures that it will be returned to the correct setting.

## FOR SIMPLICITY: JUST TWO MOVING PARTS

Consistent operation *without attention* is assured by an inner pressure seal—an "O"-ring silicone gasket—under radial pressure against a permanently lubricated surface. Manufacturing tolerances are easily controlled to assure proper gasket pressure each time for perfect sealing. Designed with only two moving parts, the device is of simple, rugged construction with every part—aluminum housing, stainless steel shaft, and silicone "O"-ring gaskets—selected for minimum maintenance.

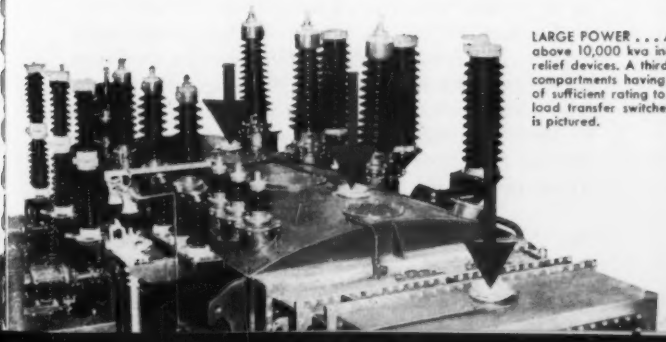
Optional extras include alarm contacts and a visual operation indicator easily reset from the ground.

* * *

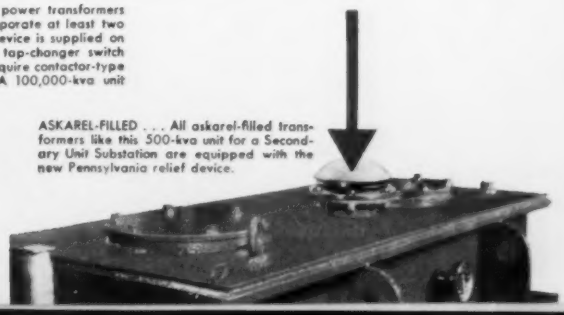
Our newly introduced Pennsylvania Transformer relief device is now available as *standard equipment* on Pennsylvania Transformers. Additional information is available on request from Power Sales Department, Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pennsylvania.

McGRAW-EDISON

# POWER TRANSFORMERS



LARGE POWER . . . All power transformers above 10,000 kva incorporate at least two relief devices. A third device is supplied on compartments having a tap-changer switch of sufficient rating to require contactor-type load transfer switches. A 100,000-kva unit is pictured.



ASKAREL-FILLED . . . All askarel-filled transformers like this 500-kva unit for a Secondary Unit Substation are equipped with the new Pennsylvania relief device.

usually the breakers that operate to isolate it.

B. Current Selection—Relays closer to the power source are calibrated to be less sensitive and do not respond to distant fault currents.

C. Time Selection—Relays nearer the power source have longer time delays and "wait" until relays near the fault have a chance to clear it.

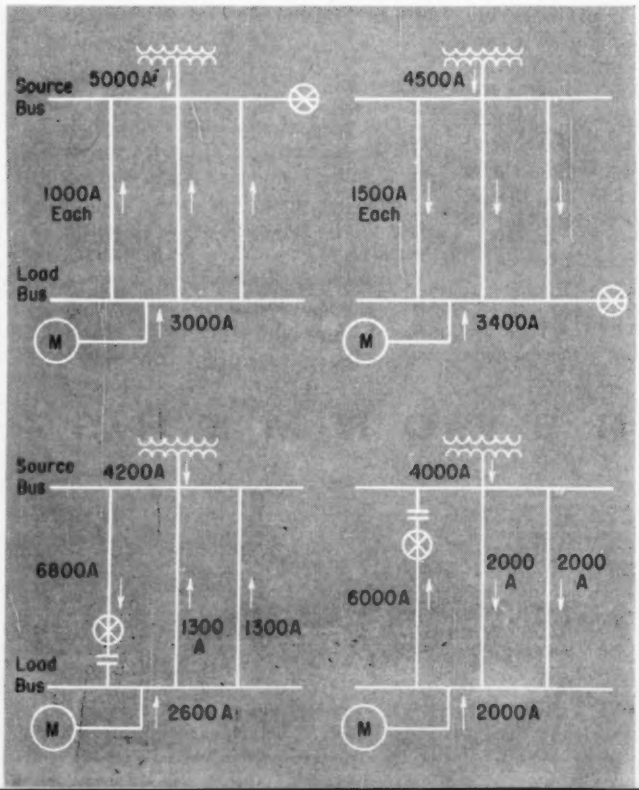
In practice, a combination of time and current selection improves the security of the relay system and provides an allowance for unforeseen factors. In some installations, instantaneous relays can improve the probability of overall coordination.

### 13. Provide Adequate Back-Up Protection

A well-planned relay system must include reliable back-up protection which is well coordinated with the first-line relaying. By judicious use of relays and setting of calibrations, back-up protection for one type of fault can often be combined with the first-line protection for other types or locations of faults.

On a poorly maintained system, where protective failures are not uncommon, the back-up protection should disconnect a minimum amount of the system so that production will not be completely disrupted at each relay failure. By contrast, a well maintained system will require back-up relays to function only occasionally and can thus use a scheme which disconnects a major part of the system. This improves reliability and reduces maintenance.

One limitation that frequently limits back-up protection is the necessity for reconciling emergency loading with the sensitivity required to see faults at a very distant location. In some instances, back-up relays have to be supplied from separate current transformers at the first line relay location. The back-up relays then trip the back-up breakers through separate control circuit facilities.




### 14. Watch Time Margin Between Relays

With maximum fault current flowing, a minimum total time of 0.5 sec should be sufficient to provide selectivity between two similar inverse time relays in series. This assumes that routine maintenance does not include regular electrical tests of the relay calibrations. If such checks are made regularly, the margin may be cut to 0.4 sec.

The 0.5 sec allowance is based on the following time requirements:

| | |
|---|---|
| 8-cycle breaker operation | 0.13 Sec |
| Coasting allowance | 0.10 Sec |
| Calibration error | 0.17 Sec |
| Unforeseen | 0.10 Sec |
| Total | 0.50 Sec |

If an auxiliary relay is used, an additional allowance must be made to cover its operation.

The breaker allowance is more than adequate if the breaker is modern. Some older style breakers will run 16 or 20 cycles. Even a modern 8-cycle breaker may take 15 or 20 cycles if the mechanism is dirty or has not been properly serviced. Breakers should be serviced as often as relays.

If relays have been calibrated with an adequate test set and then timed at the calculated critical fault values, the calibration error may be reduced slightly. The allowance for unforeseen incidents recognizes the inadequate knowledge the engineer usually has of system constants and performance. It also allows for the occasional abnormal operating conditions.

One other factor should be kept in mind: the less inverse the over-current relay, the greater the chance that performance will be correct in abnormal set-ups.

The main value of the less inverse relay lies in the engineer's ability to more accurately predict its operating time, for a given fault, over wide variations in fault currents which can result from variations in power company impedance (due to their switching lines in and out), variation in local generation or synchronous motor load, and variations in the number of active circuits on the system.

The less inverse relay also will reset quicker after a fault. The inverse definite minimum time relay is the best in this respect. This is particularly important when automatic reclosing is used on overhead feeders. The less inverse relay also approaches the definite time type of relay characteristic frequently found on the backup function of the power com-

pany's transmission circuits and hence simplifies backup coordination.

### 15. Make Allowance for Emergency Loading

The system must be able to cope with emergency loading after a trip-out and with the sustained inrush conditions that follow a severe voltage dip. Normally inrush conditions are considered on the local motor circuit, but these provisions are frequently not carried back through the system to the energy source.

During a very severe fault, synchronous machines may become unstable. If the fault is at a critical location, this instability could result from a fault duration of as little as 0.4 sec.

Faults which require an appreciable time to clear, especially if they are cleared by back-up protection, may cause surging in synchronous and induction machines. Although load conditions are usually ignored in calculating fault currents, these synchronizing currents may approach values comparable to remote fault conditions.

Failure to allow for this may prevent proper coordination in the relay system. Since it is usually impossible to make a complete calculation for these conditions, the designer should strive to have both a current and time selection built into his relay coordination plans. This minimizes the possibility of such effects causing improper trip-outs.

One does not usually think of induction motors having a stability problem. However, following a severe fault, all of the induction motors may be in an inrush condition, which may become so severe that the plant will go into a stall regardless of the relay system. The possibility of a fault cascading into a major outage is mimimized if the evaluation includes both the pre-fault load current on the circuits that remained in service and the possible substantial increase in motor load current for several seconds after the fault is cleared.

The engineer must be constantly alert against the cascading of trouble into a complete shutdown. One relay set too sensitively on a sound circuit may result in an unnecessary trip-out. This additional outage, at a critical time, can produce an overload on the remaining circuits far above the calculated load values. The result may be a complete shut-down.

### 16. Evaluate Post-Fault Conditions

The system must also be able to handle the abnormal operating conditions necessary to restore service after a trip-out. A large percentage of plant shutdowns result from reenergizing a fault. Stresses on breakers and other components are significantly greater when closing on a fault than in clearing it initially. The more adequately the fault location is defined by relay and annunciator systems, the less chance there is of reclosing on a fault.

### 17. Don't Overlook Instantaneous Relays

The value of instantaneous relays for network protection is not always recognized. Consider three circuits between a source bus and a load bus as shown on page 90. Protection for these circuits would normally be via pilot wire or the more economical directional over-current relays. Directional relays are difficult to apply, require potential as well as current sources in precise vector relations, and will operate erroneously if a potential fuse is blown.

Reliability can be significantly improved by adding non-directional instantaneous overcurrent relays to each of the six terminals. With these relays set at 2,500 amp—just above current values for fault on the load bus, a circuit fault will trip one terminal instantly and the second terminal sequentially and instantly after the first clears. When this scheme is applicable, total fault clearing times can be less than one half that with directional time overcurrent relays alone. Note that induction motors must be considered in applying instantaneous relays although their contribution is short lived and affects only high speed instantaneous relays.

### 18. Scrutinize Ground Protection

Since most faults involve ground, the engineer should give serious thought to his ground protection system. Performance of the ground protection system can be more accurately predicted during instability or surging in synchronous machines since load currents do not appear in the ground relay circuit. With good ground protection plus time and current coordination, the effects of these conditions can often be minimized.

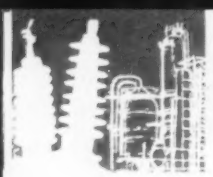
### 19. Check the System Before Using

Before any new system is put into operation, it should be thoroughly checked to make sure the scheme is functionally sound; to detect "sneaks" in complex circuits; and to test continuities, connections and grounds. At the same time, the engineer should check the ratios of all CT's and PT's.

Fault sensing relays should be inspected to see that all shipping wedges have been removed and that no damage has been done in transit. Each relay should be checked to be sure its voltage, current, and frequency ratings are right.

Test each relay electrically to confirm the pick-up value and to time its operation at some prescribed value. Results should be compared with the time dial calibration sheets furnished with the specific relay and any deviation investigated immediately.

Stage fault testing is frowned on by most companies. Usually these tests can be obviated by low voltage testing, using an isolated transformer. In extremely complicated relay schemes, an isolated generator may sometimes be used.



INDUSTRIAL
ELECTRICAL
SYSTEMS

# Need A Short Circuit Study? . . . Fast, Easy Method Is Satisfactory For Most Systems

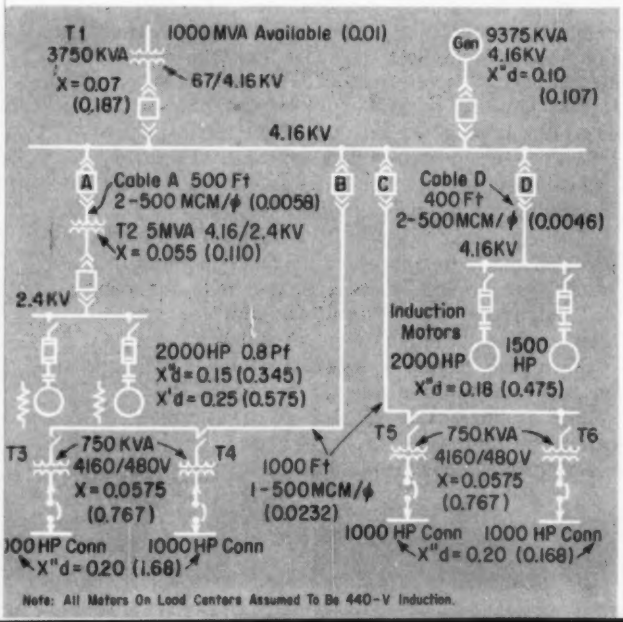
**W. C. HEINZ,** Application Engineer, General Electric Co, Cleveland, Ohio

Frequently industrial electrical engineers defer or neglect a much needed short circuit study because they erroneously believe it must be time-consuming and complicated. Actually, this reluctance is unwarranted. In most industrial systems the fault current at any point can be readily determined by a few simple relationships and straightforward arithmetic. The accuracies obtained are adequate for the great majority of installations.

Further simplification and the elimination of a great deal of repetitive arithmetic is possible by visualizing the physical flow of fault current to various locations as described below. If the proper calculating procedures are followed, the effect of irregular shape of fault current and other circuit phenomena is easily compensated for by simple multipliers. The only additional requirements are on up-to-date one-line diagram and equipment data cards.

The starting point for any system study is the one-line diagram. This will show all sources of short circuit current, including generators, synchronous machines, and induction machines. Any utility source is, of course, backed up by generation and is thus an additional source of short circuit current.

Below is an abbreviated one-line diagram such as might be encountered in a typical industrial plant.




All of the significant components which will affect the flow of fault current are shown, with their rating and effective impedence. Although this may appear an uncommonly simple system diagram, most industrial systems can be similarly reduced when making only a short circuit study.

Since the apparent reactance of a rotating machine varies with time, the type of calculation to be made determines the proper value of reactance to be used. The table on page 101 indicates which type of reactance should be used for each type of study. On the diagram each reactance is shown where applicable. Since the calculation is to be made on a per unit base, the impedances are shown both on their own base and—in parenthesis—on the 10,000-kva per unit base to be used.

To preserve the accuracy of a study, the data for the rotating machines should be obtained directly from the manufacturer and entered in the records. If time does not permit this, close estimates can be obtained either from the AIEE Redbook, Publication 952, or from the Industrial Power System Handbooks, (Beeman, McGraw-Hill Book Co.).

### Must Consider Resistance

It is apparent from the relative values of impedance on the diagram that fault current magnitude available depends primarily on the capacity of the power sources—the utility tie and plant generation —and only to a minor extent on the size of the connected load. Note that this differs from the load current magnitude, which is proportional to the process work being done and is only slightly affected by the size of the source.

The industrial engineer must also consider when and where to consider the effect of resistance or impedance, rather than just reactance. Obviously, the more accurate calculation will include the effect of resistance on the flow of short circuit current.

In a typical industrial system it is usually safe to ignore the effect of resistance in circuits of 2.4 kv and above. Similarly, the resistance of all generators, transformers, reactors, motors, and high capacity buses can usually be ignored, regardless of their voltage class.

However, in circuits of 600 v or less, the resistance contributed by cables and low rated buses may be significant enough to deserve consideration, especially if the runs are long. In any event, the vector relationship between resistance, reactance, and impedance must be maintained.

(*Continued on page* 96)

# We look inside your commutator at National

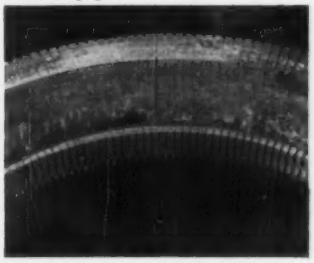
*...The Specialists in electric coils/repair service*

**AND HERE'S WHAT WE OFTEN FIND!**

Enlarged view of a dielectric puncture of a mica vee ring at the lower end of the copper bar. This is an example of interior commutator faults which may be present though exterior appears excellent.

Shifted or squirted mica at the apex of the 3° and 30° cone surfaces of a mica vee ring. The black lines on the 3°-surface were made by bar-to-bar voltage breakdown creepage.

The bar which projects above those adjacent has been locally overheated under a brush and softened.



A mica segment on the front end of the commutator has started to work out radially and will eventually result in a bar-to-bar short circuit.

When you send D-C machines to National for rewinding or rebuilding, the commutator gets a close inspection and test. But we've found from experience that a commutator that looks excellent on the surface may be in deep trouble inside... with mica cooked, varnish burned, loose copper, or imminent short circuits.

So when we are suspicious of the commutator we remove and open it for a close interior inspection. It's another added assurance that machines rebuilt by National will give you long, dependable service.

For more information, call National's Columbus plant... HUdson 8-1151. Or call the nearest National field engineer.

**National Electric Coil**

DIVISION OF McGRAW-EDISON COMPANY

COLUMBUS 16, OHIO

McGRAW EDISON

ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS • REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Now . . . you can

# CHOOSE THE TYPE OF OPERATION YOU NEED

in Westinghouse low-voltage power circuit breakers

Westinghouse provides bonus value beyond specification.
Shown here are DB-50 power circuit breakers with . . .

1 manual closing

To match your requirements, Westinghouse now offers low-voltage, Type DB power circuit breakers with a choice of manual, electric solenoid, and new spring-manual closing.

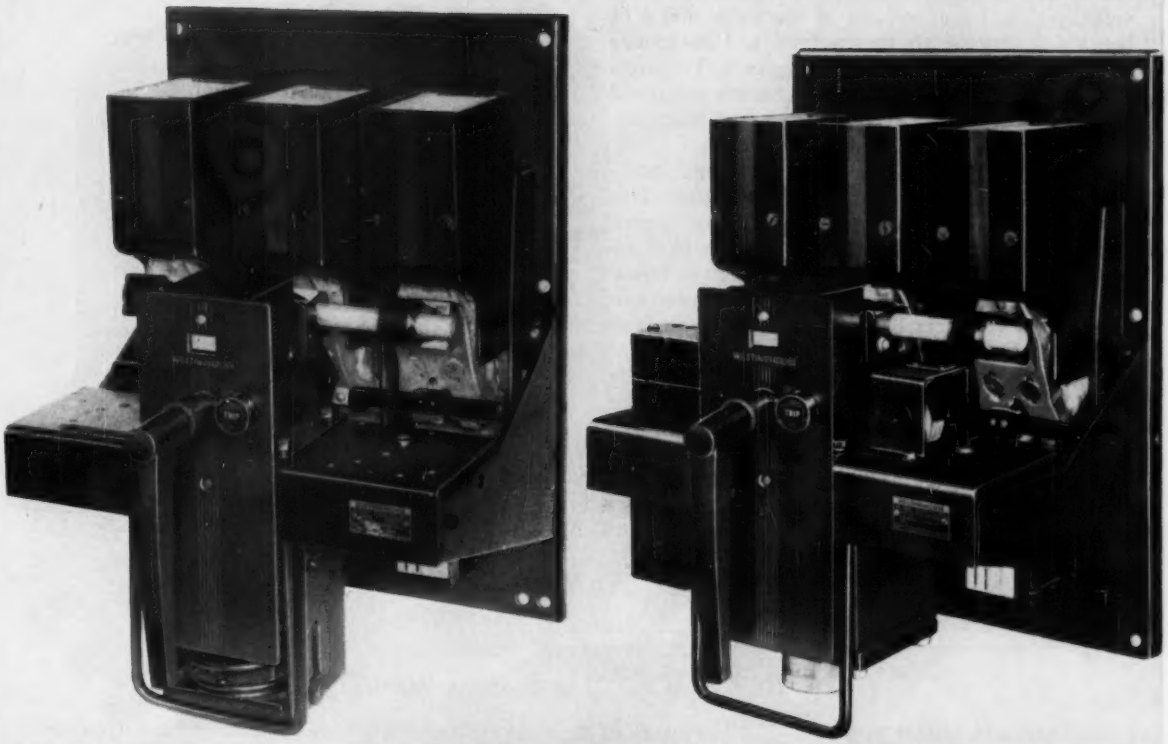
The new spring mechanism is simple, sturdy and has been fully tested. It can be used with selective-delayed trips up to the full short-time rating of the breaker and is available on the DB-15, DB-25 and DB-50. Industry standards recommend electric operation on the two largest frame sizes.

Westinghouse Type DB breakers give you ultimate protection and application flexibility for low-voltage power circuits. In addition to your choice of closing mechanisms, they adapt to any mounting —fixed, drawout or separate enclosure. All auxiliaries can be added in the field or at the factory before shipment. You get a selection of multiple tripping characteristics including: standard long delay and instantaneous; selective long delay and short delay; three-element long delay and short delay and instantaneous.

For more information on compact, versatile Westinghouse circuit breakers, contact your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-60983

YOU CAN BE SURE... IF IT'S Westinghouse WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS



**2** spring-manual closing

**3** solenoid closing

## You choose... the protection you need

Type DB-15 | Type DB-25 | Type DB-50 | Type DB-75 | Type DB-100

## You select... the type of operation you want

| Conventional Manual Closing | | Quick-Make Spring-Manual Closing | | Electric Solenoid Closing | |
|---|---|---|---|---|---|
| For Fixed Position Mtg. | For 3-Pos. Drawout Mtg. | For Fixed Position Mtg. | For 3-Pos. Drawout Mtg. | For Fixed Position Mtg. | For 3-Pos. Drawout Mtg. |

Motors operating at 2.3 kv or above are relatively few in number and can usually be represented individually. The larger number of motors at 600 v or below will vary greatly in size, type, and impedance and thus are usually handled as a group. The average equivalent impedance assumed for the group will depend on the mix between induction and synchronous machines.

For greater accuracy, the synchronous and induction motor groups on a bus may be segrated. This is not as much of a refinement as it may appear, since low voltage machines have relatively little effect on short circuit current on high voltage buses. Furthermore, both synchronous and induction motors must be represented in calculating available fault current on low voltage buses.

The actual mathematical calculation in the study that follows is made on the per unit system. (The principles of the per unit system are outlined in the box below.) This system is particularly advantageous where more than one voltage level is encountered.

The following simple calculations show the conversion of impedances from the machine rating to the 10,000-kva base. All calculations are made to slide rule accuracy only.

**A. Utility System Impedance.**

$$X_U = \frac{\text{Base kva}}{\text{Max. Available Short Circuit kva}}$$

$$= \frac{10{,}000}{1{,}000{,}000} = 0.01$$

**B. Generator Impedance**

$$X_G \text{ (p.u.)} = X_G \text{ (At Rated kva)} \times \frac{\text{Base kva}}{\text{Rated kva}}$$

$$X_G = 0.10 \times \frac{10000}{9375} = 0.107$$

**C. Transformer Impedances**

$$X_T \text{ (p.u.)} = X_T \text{ (At Rated kva)} \times \frac{\text{Base kva}}{\text{Rated kva}}$$

$$X_{T1} = 0.07 \times \frac{10000}{3750} = 0.187$$

$$X_{T2} = 0.055 \times \frac{10000}{5000} = 0.110$$

$$X_{T3} = 0.0575 \times \frac{10000}{750} = 0.767$$

($X_{T4}$, $X_{T5}$ and $X_{T6}$ same as $X_{T3}$)

(*Continued on page* 100)

## How The Per Unit System Works

A per unit system simply refers all numbers to a common base. In our numerical system, all numbers are referred to a base of one. However, since the electrical data to be used in the short circuit calculation is based on the rating of the machine or apparatus involved, and since most electrical systems use equipment of many ratings, a different base must be used in calculating electrical impedances.

In system calculations, the engineer is concerned with kva, kv, amperes, and ohms. Since these terms are all related by Ohm's law, values for any two of the terms—e.g., kva and kv—may be arbitrarily selected and the others then calculated by the formulas below. These formulas refer to 3-phase circuits; similar but not identical relationships hold for single-phase circuits.

$$\text{Base Amp } (I_B) = \frac{\text{Base kva}}{\sqrt{3} \times \text{Base kv}}$$

$$\text{Base Ohms } (X_B) = \frac{(\text{Base kv})^2 \times 1000}{\text{Base kva}}$$

In a system where several voltages are involved, the base voltages selected for the different levels of the system must have the same relationship as the transformer ratios, including the effect of transformer tap settings. Thus when a base voltage is selected for one of the voltage levels, the base voltages for all other system voltage levels are automatically determined, with a relationship corresponding to the actual physical ratio of the transformer windings.

As indicated above, the two components normally selected as the starting point in a system study are kv and kva. Any number may be selected for the kv base, although it is usually one that exists in the distribution system. Frequently the main distribution voltage is used.

The number selected for the kva base is usually the rating of one of the larger machines or transformers or, to simplify conversions, a round number such as 10,000 kva. The impedance of apparatus which is not the same as the selected base must then be converted as follows:

**Correction for kva:**

$$\text{Impedance on Base kva} = \text{Impedance at Rated kva} \times \frac{\text{Base kva}}{\text{Rated kva}}$$

**Correction for voltage**

$$\text{Impedance at Base V} = \text{Impedance at Rated V} \times \left(\frac{\text{Rated V}}{\text{Base V}}\right)^2$$

These corrections must be made when either the rated kva or the rated voltage differs from the base values selected. If both differ, both corrections must be made. All impedances are phase-to-neutral.

## RIGHT FROM THE START

When piping costs come close to the million mark—when the installation is vast, and the leeway for error is small—a piping job must be right from the start to finish. Grinnell assures this through complete one-company control and responsibility. From interpretive engineering—through exclusive methods of prefabrication and testing of pipe and hanger units—to precision assembly and delivery, the job is all done by Grinnell, as only Grinnell can do it. The result: installations of any size, at costs known before you start, with assured performance. Grinnell Company, Inc., Providence, R. I.

**Current Grinnell piping responsibilities.**
Enrico Fermi Atomic Power Plant, Michigan; Ohio Power Company, West Virginia; National Aniline Division of Allied Chemical & Dye Corporation, Virginia; Memphis Light, Gas and Water Division, Tennessee; Aluminum Company of America, Indiana; South Carolina Electric & Gas Company, South Carolina; Duke Power Company, North Carolina; Union Bag-Camp Paper Corp., Virginia; Pennsylvania Power & Light Company, Pennsylvania; Holyoke Water Power Company, Massachusetts.

GRINNELL

GENERAL CONTRACTORS: Campbell Construction Co., Detroit, Mich.
ARCHITECT & ENGINEERS: Campbell Engineering Co., Detroit, Mich.
ELECTRICAL CONTRACTOR: Southeastern Electric Co., Detroit, Mich.

# Electrical Protection goes MODERN *with* BUSS Fuses

## in the Hoover Tool & Die Co., Centerline, Mich.

This new industrial plant on the outskirts of Detroit illustrates that the modern trend in electrical protection is to fuses. The main switch gear is a 1600 ampere pressure switch protected by BUSS Hi-Cap fuses. The distribution panels, both power and light, are equipped with FUSETRON dual-element fuses.

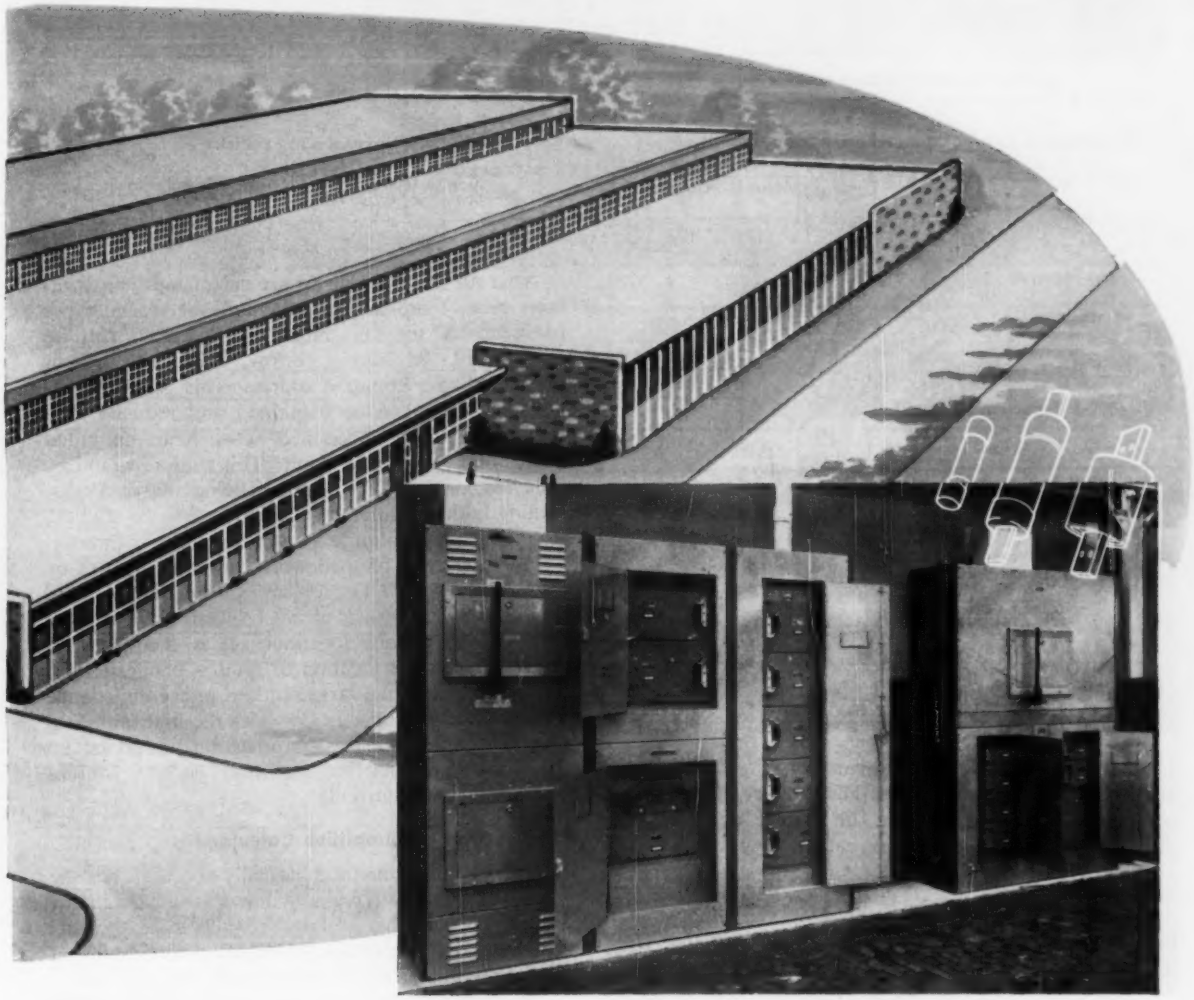
This plant will have many operating advantages because fuses are installed. *For instance:*

**Future expansion without sacrificing safe protection.**

Provisions were made to install a second 1600 ampere pressure switch when needed. This additional capacity and any increase in available fault current can safely be handled by BUSS Hi-Cap and FUSETRON dual-element fuses.

The interrupting rating of BUSS Hi-Cap fuses is 200,000 amperes rms symmetrical — and for FUSETRON fuses it is 100,000 rms symmetrical.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION



*Main Power Panels —*
*BUSS Hi-Cap and FUSETRON Fuses*

**Through the year's savings result from the greater dependability of fuses.**

Unlike mechanically operated devices, a fuse has no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

After years of service, a fuse will give the same safe, dependable protection if called upon to open as it would have given on the day it was installed.

The dependability of BUSS Hi-Cap and FUSETRON fuses helps to reduce costs — by preventing damage and loss due to electrical faults — by being maintenance free — by requiring no periodic inspections — and by eliminating shutdowns caused by needless outages.

Is it any wonder then that "ELECTRICAL PROTECTION IS GOING MODERN WITH FUSES"? No other type of protective device can match the combined high-interrupting capacity, dependability and maintenance-free features of fuses.

*For more information*

On BUSS Hi-Cap fuses . . . . *Write for bulletin HCS*

On FUSETRON dual-element fuses . . . . *Write for bulletin FIS*

859

**BUSSMANN MFG. DIVISION, McGraw-Edison Co. ST. LOUIS 7, MO.**

**D. Motor Impedances**—(Assuming one kva per hp)

$$X_M \text{ (p.u.)} = X_M \text{ (Rated kva \& V)} \times \frac{\text{Base kva}}{\text{Motor Rated kva}} \times \left(\frac{\text{Rated Motor V}}{\text{Base V}}\right)^2$$

**Syn. Motors** ($X_{SM}$)

$$X''d = 0.15 \times \frac{10000}{2000 \times 2} \times \left(\frac{2300}{2400}\right)^2 = 0.345$$

$$X'd = 0.25 \times \frac{10000}{4000} \times \left(\frac{2.3}{2.4}\right)^2 = 0.575$$

**4000-V Induction Motors** ($X_{IM}$)

$$X''d = 0.18 \times \frac{10000}{3500} \times \left(\frac{4000}{4160}\right)^2 = 0.475$$

**440-V Induction Motors.**

$$X''d = 0.20 \times \frac{10,000}{1,000} \times \left(\frac{440}{480}\right)^2 = 1.68$$

**E. Cable Impedances**

Cable data in standard tables is given in ohms per unit of length and must be converted to p.u. values:

$$\text{p.u. Ohms} = \frac{\text{Actual ohms}}{\text{Base ohms}}$$

$$\text{Base Ohms} = \frac{(\text{Base kv})^2 \times 1000}{\text{Base kva}}$$

From this it is obvious that cables with identical actual ohmic values will have different per unit impedance values depending on the voltage at which they are applied. For 4.16-kv cable:

$$\text{Base Ohms} = \frac{(4.16)^2 \times 1000}{10000} = 1.73 \text{ Ohms}$$

Impedance of 3-conductor 500-MCM, 5-kv cables is approximately 0.04 ohms per 1000 ft.

**Cable A**—two cables in parallel — 500 ft. each

$$X_{CA} = 0.04 \times \frac{500}{1000} \times \frac{1}{2} = 0.01 \text{ Ohms}$$

$$\text{p.u. Impedance} = \frac{\text{Actual Ohms}}{\text{Base Ohms}} = \frac{0.01}{1.73} = 0.0058 \text{ p.u.}$$

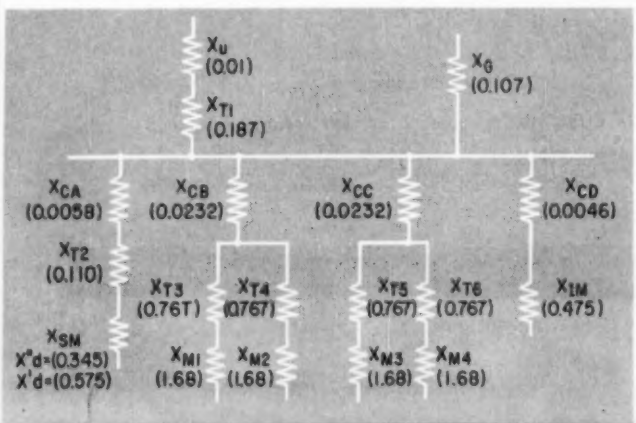
**Cable B**—1000 ft.

$$X_{CB} = 0.04 \times \frac{1000}{1000} = 0.04 \text{ Ohms}$$

p.u. Impedance = 0.04/1.73 = 0.0232 p.u.

**Cable C**—1000 ft.

Same as Cable B = 0.04 ohms = 0.0232 p.u.




**Cable D**—400 ft.—two cables in parallel.

$$X_{CD} = 0.04 \times \frac{400}{1000} \times \frac{1}{2} = 0.008 \text{ ohms}$$

$$\text{p.u. Impedance} = \frac{0.008}{1.73} = 0.0046 \text{ p.u.}$$

After all the impedances are calculated on a common base, there are two methods of working the problem. A separate impedance diagram can be constructed, as shown below, with all sources connected to a common source. This group of impedances can then be combined and reduced to a single equivalent impedance between an unlimited source and the point of fault. This routine would be followed for each fault location being analyzed. Assuming faults at different locations are to be studied, this can amount to quite a lot of repetitive arithmetic.

However, a lot of spadework can be eliminated by examining the one-line or impedance diagram and visualizing the physical flow of short circuit current to faults at various locations. It is then easy to realize that as the location of fault is changed from one point to another, large sections of the impedance circuitry are unchanged. Consider the first fault at a central location, such as the main bus, and sum up the individual contributions from various sources into a total fault current.

### Shorter Method Simplifies Calculations

Although, each method basically accomplishes the same thing, the latter eliminates drawing the many impedance diagrams as the system is systematically reduced. It is particularly helpful where faults at many different points are considered.

Since calculation is made on a per unit basis, the infinite voltage source is 1.0 p. u. voltage. The current is therefore I =

$$\frac{V}{X_E} = \frac{1.0}{(\text{Per Unit } X_E)}$$

where $X_E$ is the equivalent impedance between the infinite source and point of fault. There are several sources and each can be analyzed separately. Of course,

$\frac{1}{(I)} = X_E$ so current and impedances are reciprocals.

Referring to the one-line diagram, the momentary requirements for circuit breakers on the main 4.16-kv bus are now calculated. Since this is a calculation of the maximum RMS current during the first half-cycle, the contribution of induction motors must be considered and the sub-transient reactance (X″d) must be used in representing the synchronous motors. Note from the table that the generator is always represented by its sub-transient reactance whether the calculation is for momentary current or interrupting current.

Where several impedances are in series, simply add impedances before taking the reciprocal of the sum to find per unit current contribution.

## MULTIPLYING FACTORS & REACTANCES FOR SHORT CIRCUIT CALCULATIONS

| Type of Equipment & Duty | Equipment Location in System | Asymmetry Multiplying Factor | Machine Reactance to Use: Generators Syn Conv Syn Cond Freq. Changers | Machine Reactance to Use: Syn Motors | Machine Reactance to Use: Induction Motors |
|---|---|---|---|---|---|
| **POWER CIRCUIT BREAKERS, ABOVE 600 V** | | | | | |
| INTERRUPTING DUTY | | | | | |
| 8 cycle or slower (General Case) | Symmetrical | 1.0 | Subtransient | Transient | Neglect |
| 5 cycle | SC Duty < 500 | 1.1 | | | |
| 8 cycle | Symmetrical SC | 1.1 | | | |
| 5 cycle | Duty > 500 MVA | 1.2 | | | |
| MOMENTARY DUTY | | | | | |
| General Case | Near Generating Station | 1.6 | Subtransient | | |
| Less than 5 KV | Remote from Gen. (X/R Ratio < 10) | 1.5 | | | |
| **HIGH VOLTAGES FUSES & FUSED INTERRUPTER SWITCHES ABOVE 600 V** | | | | | |
| 3-PHASE KVA INTERRUPTING DUTY | | | | | |
| All Types, Including All Current Limiting Fuses | Any location | 1.0 | Subtransient | Transient | Neglect |
| MAX RMS AMP INTERRUPTING DUTY | | | | | |
| All Types, Including All Current Limiting Fuses | Any location | 1.6 | Subtransient | | |
| Non-current Limiting Only, Below 15 KV | Remote from Gen. (X/R Ratio < 10) | 1.2 | | | |
| **HIGH VOLTAGE FUSED MOTOR STARTERS, 2.4 & 4.6 KV All HP Ratings** | | | | | |
| 3-PHASE KVA INTERRUPTING DUTY | Any Location | 1.0 | Subtransient | Transient | Neglect |
| MAX RMS AMP INTERRUPTING DUTY | Any Location | 1.6 | | Subtransient | |
| **HIGH VOLTAGE MOTOR STARTERS, 601V to 5KV CB or CONTACTOR TYPE** | | | | | |
| INTERRUPTING DUTY | Any Location | 1.0 | Subtransient | Transient | Neglect |
| MOMENTARY DUTY | Any Location | 1.6 | Subtransient | | |
| | Remote from Gen. (X/R Ratio < 4) | 1.5 | | | |

The calculations for the momentary current are:

| Impedance | Current |
|---|---|
| **Contribution from Generator** | |
| $X_G = 0.107$ | $I = 9.37$ p.u. amp |
| **Contribution from Utility** | |
| $X_U = 0.01$ | |
| $X_{T1} = \frac{0.187}{0.197}$ | $I = 5.08$ p.u. amp |
| **Contributions from Synchronous Motors** | |
| $X_{SM} = 0.345$ | |
| $X_{T2} = 0.110$ | |
| $X_{CA} = \frac{0.0058}{0.4608}$ | $I = 2.17$ p.u. amp. |
| **Contribution from Induction Motors** | |
| $X_{IM} = 0.475$ | |
| $X_{CD} = \frac{0.0046}{0.4796}$ | $I = 2.08$ p.u. amp |

**Contribution from 440-V Induction Motors** (Circuit B)

$X_M = 1.68$

$X_{T3} = \frac{0.767}{2.447}$ $I = 0.408$ p.u. amp

$\frac{\times 2}{0.816}$ p.u. amp, and $\frac{1}{I} = 1.225$

$X_{CB} = \frac{1.225}{\frac{0.0232}{1.2482}}$ I = 0.80 p.u. amps

Circuit C same as Circuit B.

$X_C = 1.2482$ $I = 0.80$ p.u. amp

Total Fault Current = 20.30 p.u. amp

Thus, the total **symmetrical** per unit fault current which would flow into a bus fault is 20.30. To convert this to actual amperes, simply multiply the p.u. amperes times the base amperes. The base amperes

(1.0 per unit) at any voltage level is equal to $\frac{\text{Base kva}}{\sqrt{3} \times \text{Base kv}}$. Thus the base current for this assumed fault is $\frac{10000}{\sqrt{3} \times 4.16} = 1{,}390$ amp.

Fault current is 20.30 x 1,390 = 28,200 symmetrical amperes. In the table, it will be noted that the multiplier to compensate for asymmetry in the fault current under the assumed conditions is 1.6. Therefore, the asymmetrical current = 1.6 x 28,200 = 45,200 amp. Thus any equipment applied to this system at this voltage must withstand the mechanical forces developed by 45,200 amp; i.e., have a momentary rating of at least 45,200 amperes.

Next calculate the requirements of interrupting devices applied to this system. Assuming the circuit breakers at this voltage will interrupt fault current in approximately 5 cycles, the contribution from the induction motors has in this time died out and need not be considered. Contribution from the utility and the generator is the same as previous calculation:

| | |
|---|---|
| Generator | $I = 9.37$ p.u. amp |
| Utility | $I = 5.08$ p.u. amp |

Contribution from Synchronous Motors—(Use transient reactance, from the table)

$X_{SM} = 0.575$
$X_{T2} = 0.110$
$X_{CA} = \frac{0.0058}{0.6908}$ $\quad I = \frac{1.45 \text{ p.u. amp}}{15.90 \text{ p.u. amp}}$

Interrupting Current = 15.90 × 1,390 = 22,100 amp
Interrupting kva = 15.90 × 10,000 = 159,000 kva

Therefore, circuit breakers applied at this point in the system should have an interrupting rating at least equal to 159,000 kva and a momentary rating of at least 45,200 amps. For selection of other types of devices, such as fuses, the proper multipliers and impedances, as indicated in the table, should of course be used.

Carrying the calculation a step further, calculate the fault current on one of the 480-v load center busses. Low voltage air circuit breakers will interrupt fault current in the first cycle or so after the inception of the fault. Consequently all induction motors in system must be considered.

Previously we found the total fault current to a fault on the 4,160-v bus is 20.30 per unit. The contribution from all sources except one load center feeder is 20.30 minus 0.80 (contribution from Feeder B) = 19.50. The equivalent impedance representing all of the system except Feeder B is the reciprocal of 19.50 or 0.0513 pu.

Adding impedances in series where applicable, considering fault current sources as we move out along the feeder toward the load center, using the reciprocal relationship of current and impedance, the calculations are as follows:

$X_{(System-B)} = 0.0513$
$X_{CB} = \frac{0.0232}{0.0745}$ $\quad I = 13.42$ p.u. amp
$X_M = 1.68$
$X_T = \frac{0.767}{2.447}$ $\quad I = \frac{0.408 \text{ p.u. amp}}{13.828 \text{ p.u. amp}}$ and

$\frac{1}{I} = 0.0723$

$X_T = \frac{0.767}{0.8393}$ $\quad I = 1.190$ p.u. amp
$X_M = 1.68$ $\quad I = \frac{0.595}{1.785 \text{ p.u. amp}}$

Thus the maximum symmetrical fault current available at the 480-v bus is 1.785 per unit current. Of course, base amperes are different at 480 v than they were at 4,160 V as indicated by the formula:

$$\text{Base Amp} = \frac{\text{Base kva}}{\sqrt{3} \times \text{Base kv}} = \frac{10000}{\sqrt{3} \times .480} = 12{,}030 \text{ amp at 480 V.}$$

Maximum symmetrical fault current = 12,030 × 1.785 = 21,500 amp. Any circuit breaker applied to this particular 480-v bus would have to have the ability to interrupt these symmetrical amperes.

It might be noted that only recently have low voltage power circuit breakers been rated in symmetrical amperes. In the past, the basis of their rating has been asymmetrical amperes and the asymmetry depends a great deal on the ratio of reactance to resistance in the equivalent system.

The multiplying factor generally used with a calculation at this voltage is 1.25. Thus, for a typical industrial system the asymmetrical current is obtained by multiplying the symmetrical amperes by 1.25. Tables and curves available in the AIEE Red Book and the Industrial Power Systems Handbook will indicate the multiplying factor to use if the X/R ratio is less than approximately 10.

The calculation shows the current available for a bolted three-phase fault. This is the type of calculation required when selecting interrupting devices since they must be able to interrupt the maximum fault current available.

Line-to-line faults or line-to-ground faults can be calculated and analyzed by the use of symmetrical components but such calculations are not generally necessary in typical industrial plant distribution systems. For most installations, the maximum current flowing in a line-to-line fault can be estimated at 87% of that calculated for a bolted 3-phase fault.

The magnitude of line-to-ground fault current is dependent on the method of grounding; i.e., whether intentional impedance, either reactance or resistance, is inserted in the neutral grounding circuit. For a solidly grounded industrial system it is generally assumed that the ground fault current can be as great as a bolted 3-phase fault current. For typical resistance grounded systems, it can usually be assumed the resistance is the limiting item in the impedance circuit.

In addition to the standard pull-out test shown, Burndy designed a special 50 foot test rack to develop a new connector concept: the single sleeve ACSR splice—UNISPLICE
BURNDY TESTING

# concentrates

## ON DEVELOPING BETTER ELECTRICAL CONNECTIONS

Developing new and better ways to make electrical connections is our total job at Burndy. Finding out exactly what happens to cable and connectors under normal and extreme operating conditions and then designing a connector that meets the conditions requires Burndy's specialized test facilities: vibration, heat cycling and heat run... conductivity... salt spray... constant tension and constant motion... pull-out... dielectric and other special tests.

Remember, Burndy is the only electrical manufacturer concentrating all its extensive facilities on the development of better electrical connections...

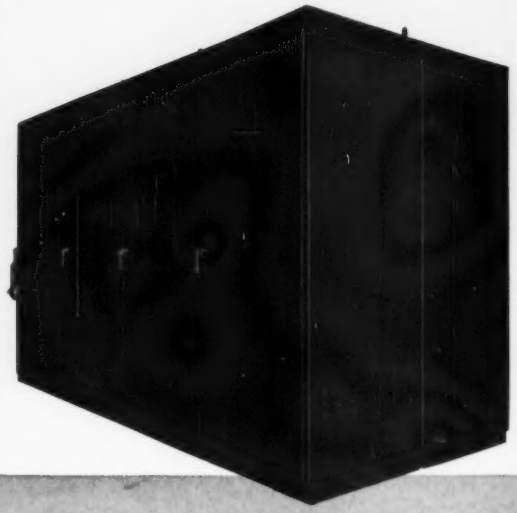
## RESEARCH, TEST, DESIGN AND PRODUCTION LEADERSHIP

# BURNDY

58-20

Norwalk, Connect. In Europe: Antwerp, Belgium Toronto, Canada

# for high voltage service continuity on your critical loads at lower capital outlay— it's S&C Metalclad Switchgear!

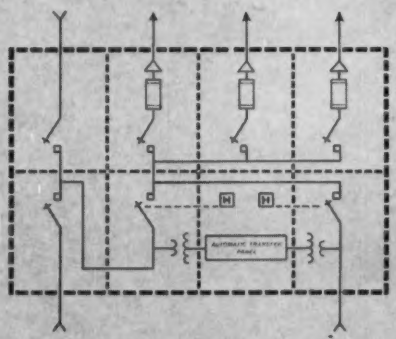


To get service continuity on critical loads, you need preferred-to-emergency switching of your alternate incoming high-voltage supply circuits, and short-circuit protection and switching on your outgoing high-voltage supply feeders. All of this can be provided in one low-cost package in S&C Metalclad Switchgear, as illustrated.

You even have built-in choices of throwover schemes through S&C's standard automatic transfer panels.

You save two ways:

1. You get metalclad switchgear with job-matched load interrupters and power fuses, in lieu of costly circuit breakers.
2. You eliminate cost of custom designing by using an off-the-shelf transfer panel with built-in options.



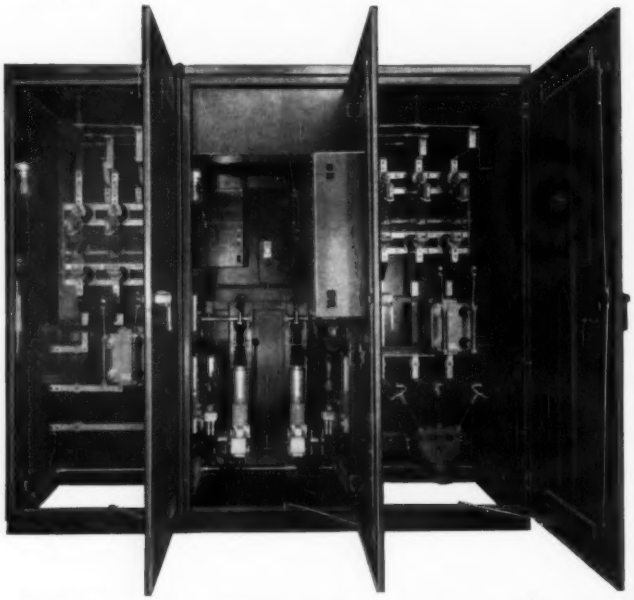
Schematic for 8-bay switching center unit (above) shows throwover control of 2 of 3 alternative incoming sources to provide continuous service for three outgoing feeders.

S&C Standard Automatic Transfer Panel provides for making either source preferred, for automatic or manual return, for adjustable time delays, for choice of returning in either open or closed transition, and for optional lockout on bus faults.

No organic insulation to cause corona trouble; porcelain and air only.

High-Speed Automatic Switching.

Full-length bulkhead doors; rainproof, with complete access.



Super Durabake finish with galvanized and stainless steel hardware; withstands corrosive atmospheres.

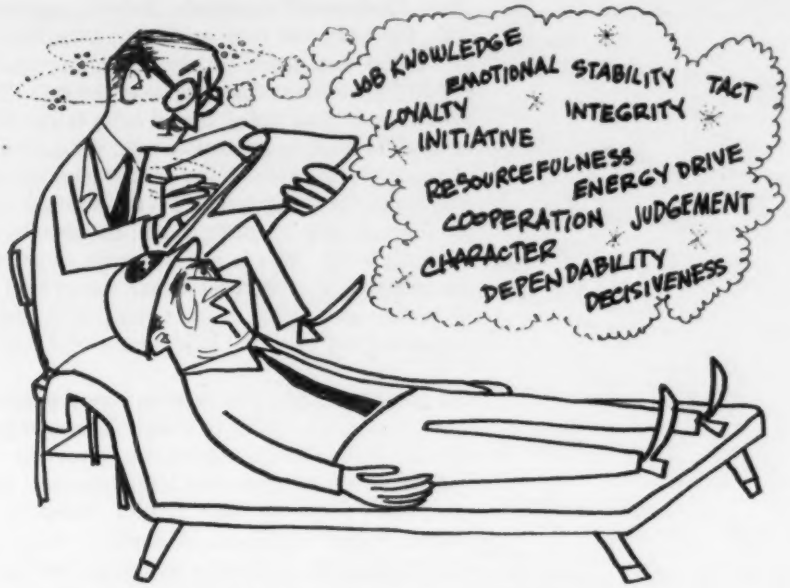
Separate compartment for Moto-Draulic operators; free access and decoupling for checkout.

Strip heaters with adequate venting prevents moisture accumulation.

Power Fuses
Tool Operated Disconnects
Open and Enclosed Cutouts
Fuse Links
"Loadbuster"
Load Interrupters
Metalclad Switchgear

**S&C ELECTRIC COMPANY**
4421 Ravenswood Ave., Chicago 40, Ill.

In Canada: S&C Electric Canada, Ltd.
8 Vansco Road, Toronto 14, Ontario




**Unless you're a psychiatrist, you may want to try . . .**

# Rating Managers by Job Standard

Report on
Management
Development

**To do a really good job of rating his foreman** on the typical "supervisor evaluation sheet," a utility manager would have to combine the wisdom of Solomon with the psychological insight of Sigmund Freud. And when the time comes to explain this evaluation to the foreman, he might find that the tact of Emily Post would also come in handy. Since few managers are made up of this combination of ingredients, however, there's a chance that the rating will lack something in accuracy; and that the foreman, when he is told about it, may feel that his boss has been unjust.

**Elimination of this ticklish and often embarassing situation** is the aim of a group of personnel men in the utility industry. This group feels that subordinate managers should be evaluated for advancement in the company by their performance, rather than their psyches. In their view, the present system of appraisal is not objective and sometimes gets poor results. They are trying to develop a truly objective approach to measuring manager performance. There's nothing new about the idea—the news is that they have made some substantial progress toward this goal. The spadework has already been done on a plan to rate supervisors against a written, objective standard. Basic standards have been completed, and a few electric companies are now refining them to fit their own needs.

Two years ago Ivor Mall, director of the industrial relations department of Ebasco Services, Inc, enlisted the cooperation of a group of utility men to work out the details of this new approach. Many utility industrial relations men and other managers had for some time been concerned about the conventional method. Typically, it worked like this: Each manager made periodic appraisals of his subordinate supervisors, recording his judgments on a form which became a permanent record. The form itself listed a series of traits for evaluation, and usually the list was heavy with personality traits (e.g. Adaptability, Ambition, Character, Decisiveness, Emotional Stability). Each trait could be scored in five or six degrees, to give it the character of a measuring scale. With the aid of an instructional guide, the manager filled out this form. After having finished it,

he was called on to discuss it with the subordinate, for the basic purpose of telling him how he stood with the company and with the boss.

**These "trait-based" appraisals, the group agreed, had some drawbacks.** To begin with, the traits and their qualifying adjectives did not have the same meaning to all who used them. In one recent survey, 75 high-ranking executives furnished 147 different descriptions of the trait "Dependability," and showed little agreement in their definitions of other traits. More important, the conventional method set itself an impossible task: the analysis of the "whole man" on a piece of paper with the aid of a few dozen nouns and adjectives. By relying on personality traits, the rating system put the manager in the position of judging not only the subordinate's job performance, but also (by implication at least) his worth as a human being. This is not conducive to good relations between superior and subordinate. As a practical matter, it may lead the superior to duck the issue or to explain the rating in some superficial way that allows him to avoid the unpleasantness of sitting in judgment of the subordinate's behavior attitudes.

**The group's remedy was to write down detailed job performance standards** to take the place of the list of traits. These standards would allow the manager to measure how well his subordinate supervisor did his work and to avoid the impossible task of appraising his personality. No longer must the boss resort to generalities about his subordinate's "Integrity" or "Energy Drive," the group claims. With a written set of standards before him, he can say just where the subordinate fails to measure up and just where he performs exceptionally well.

**The trick is to write down usable standards.** Experienced supervisors have been using standards—consciously and unconsciously—for years. But these were seldom written down. Mall's group proposed to write them down in enough detail to make it clear to the subordinate as well as the supervisor just what is expected. This is no small trick, as the group discovered. They started out by trying to write a set of standards for a line foreman. To do this, they assembled personnel men, general foremen, and line foremen from five utilities. Working separately and checking results, they went through four steps:

- **Job descriptions:** The first step in developing standards of job performance is to find out just what the job is. Job descriptions were obtained from the line foremen and from the general foremen—all of whom had been line foremen before assuming the next higher job.

- **Job components:** In order to organize the job description into standards that can be used for evaluating performance, it must be broken down into logical components which contribute to identifiable results. The composite of all these segments makes up the total job.

- **Performance standards:** Within each segment of the job, it is necessary to define the results expected, and then to write down the standards of performance required to achieve those results.

- **Performance valuation:** These standards must be put together in such a way that the manager can appraise overall job performance through an organized review of all the standards for all the segments of the job.

**After much effort, the group feels that it has come up with a usable standard** for the job of line foreman. They are now working on standards for general foremen. On the opposite page is one segment of the standard for line foremen, with a list of all the other segments. The entire standard consists of 85 separate rating points and covers ten pages of standard paper.

**Here's how the standards can be used.** First, the general foreman and all the line foremen get a copy ahead of time. Thus they are familiar with it before any performance appraisal is made. They know what standards they are judged by, and their boss does too. When the time comes for appraisal, the general foreman

# Here's a Portion of the Basic Standard for Line Foremen:

SEGMENTS

of the

LINE FOREMAN'S JOB

A. Knowlege of Work
B. Organization of Work
C. Leadership
D. - Productivity
E. Safety
F. Material, Equipment, Tools
G. Records and Reports
H. Union Relations
I. Company Relations
J. Public Relations

(8) - maintains a familiarity with the requirements for joint occupancy of poles and crossings with other utilities, and an awareness of relationships with the underground facilities of other utilities

(9) - keeps up-to-date on developments in line work and improvements in equipment and methods through foremen's meetings, articles and bulletins circulated for his information, and through independent observation, reading and study

B. ORGANIZATION OF WORK

Work planning involves the coordination of labor, materials and equipment. Each job must be visualized in advance of starting work. The members of the crew will work most effectively if they understand how the job is organized and the sequence in which work operations will be performed. In the interest of efficiency, idle time must be held to a minimum, materials must be properly distributed and equipment advantageously utilized. The LINE FOREMAN is in a position to conserve time, material and money through the effectiveness with which he plans and schedules the work required to complete assigned jobs.

The LINE FOREMAN will be regarded as organizing his work in a satisfactory manner, when he

(10) - demonstrates the ability to visualize a completed job as described in the written work order, and plans the methods for doing the work and the order in which the work operations will be performed

(11) - assembles assigned work orders and analyzes them for adjacent or related work locations as a means of gaining efficient utilization of work time and minimizing travel time.

(12) - determines requirements for materials and equipment and issues stores orders and equipment requisitions in advance of needs

(13) - plans location of material on job site and arranges for distribution of material at locations where it will be needed, and places truck and equipment where they can be utilized most effectively

(14) - recognizes the manpower limitations of his crew and arranges for additional manpower in accordance with the size or the nature of the job

(15) - describes and explains the over-all job to members of his crew, outlines the sequence of work operations, assigns work, and calls attention to problems that may be expected and precautions which may be required



(16) - plans for and arranges interruptions as required in connection with the job and on a basis that will cause minimum inconvenience to customers and the public

(17) - arranges for and coordinates necessary switching operations and informs responsible authority in connection with circuit changes

(18) - works closely with construction supervisors, contractors or others working on related jobs and coordinates his progress with the related portions of the work

(19) - remains alert to unusual field conditions involving obstacles or hazards and takes advance steps to eliminate or overcome the problem

C. LEADERSHIP

The LINE FOREMAN is responsible for the direct supervision of a working crew. He has the responsibility and the authority to direct their work. He must function as a leader in effectively carrying out work assignments. Leadership involves the motivation, training and guidance of his crew and their working together in a cooperative and harmonious manner. Working attitudes are most favorable when based upon mutual respect, confidence and understanding. The quality of leadership that the LINE FOREMAN exercises governs the morale of his crew, has a direct bearing on the level of productivity achieved, and influences the cost of completed work.

The LINE FOREMAN will be regarded as meeting the requirements for leadership in a satisfactory manner, when he

(20) - demonstrates the ability to supervise [illegible] of his crew in a

rates the line foreman on each of the 85 points—as "satisfactory," "unsatisfactory," or "excellent." When he reviews his rating with the line foreman, the general foreman explains each "unsatisfactory" or "excellent" rating. He can explain it with facts. The standards are so set up that these explanations do not concern themselves with personalities.

**For example, consider the case of crusty old Line Foreman X,** who knows his job and has been doing it well for twenty years. Given to loud and colorful speech when correcting his men, he is nevertheless well liked and greatly respected by them. Foreman X has caused complaints because he has occasionally bawled out young linemen within earshot of housewives, and used "foul and abusive language" in the process. Under the trait-based rating system, this might show up as a low mark in "Judgment" or even "Emotional Stability"—or it might not show up at all.

Under the job-performance-standard system, this could appear as an "unsatisfactory" grade under point 78—"Trains the members of his crew to use proper language, make a courteous approach, and utilize tact and diplomacy in contacts with customers and the public." His boss could thus put into the rating a fair statement of one of Foreman X's shortcomings without impugning his judgment or his sanity.

**But there are other advantages to evaluation by standards,** the pioneers of this method claim. Besides making appraisals fairer, more exact, and less likely to cause hard feelings, experience has shown that the standards help both superior and subordinate to do their jobs well. First, standards help them get together on just what is expected on the job. They give the subordinate a way to measure his own progress. They give the superior a sound basis for counselling and help him sharpen up training to fit individual needs. They make it easier to identify promotable employees and reduce the possibility of promoting the wrong people. They increase the subordinate's feeling of responsibility and promote initiative by defining the limits of his job and giving him the freedom to act within those limits.

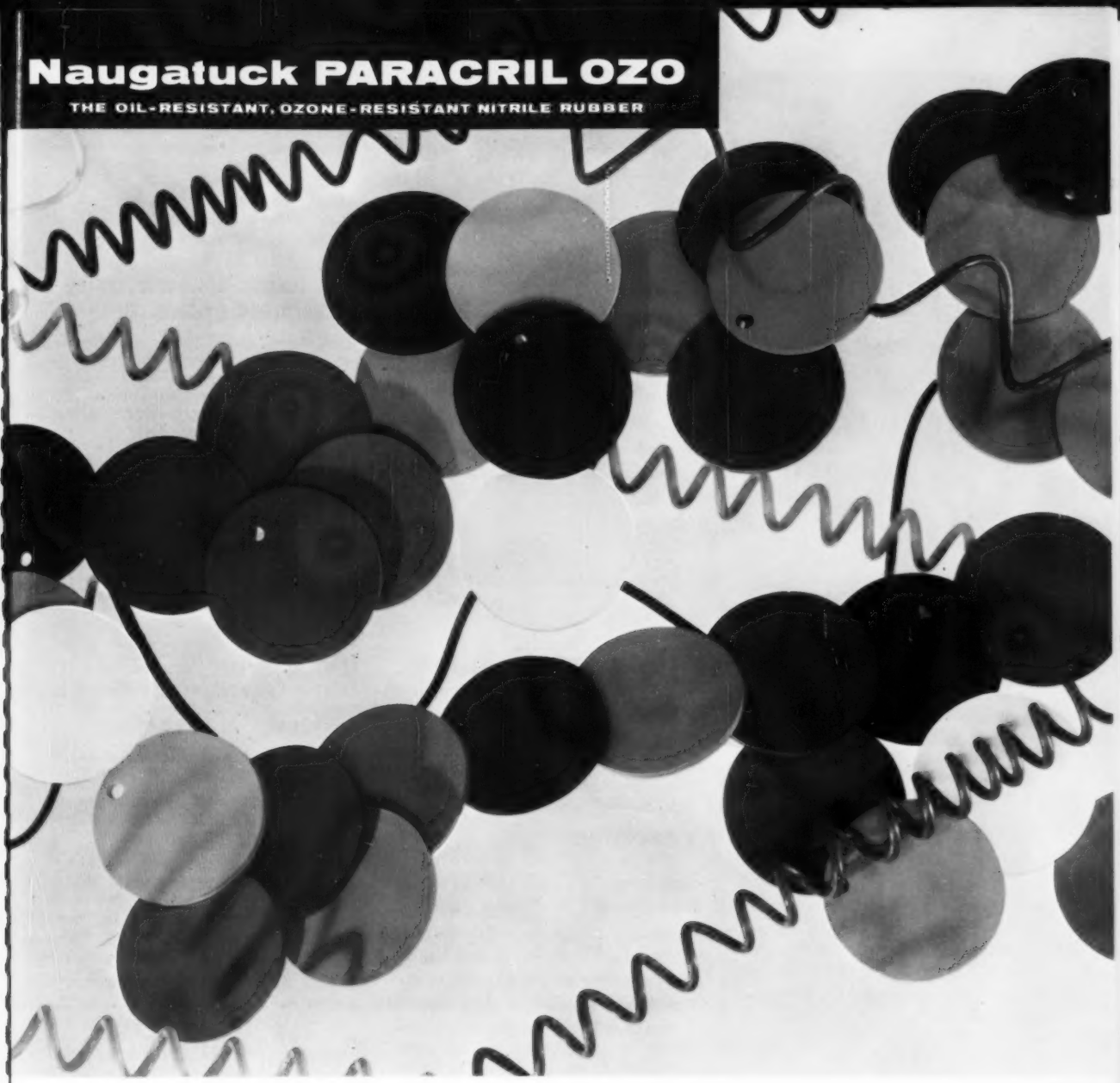
**If the standards are that good, why haven't they been universally adopted?** Mall admits that there's a significant amount of management resistance to the idea. He says: "The great 'bugaboo' appears to be the necessity of putting standards in writing. The written word has a sort of mystic significance, and many managers are extremely hesitant to put things of this nature in writing. . . . Some have the feeling that the purpose of standards is to hold the club of accountability over someone's head. . . . Experience has shown, also, that prestige is a powerful factor impeding the use of standards. When appraisals are made on the basis of results, the boss tends to get less satisfaction because his subordinates cease striving mainly to please him, and start aiming for agreed-upon goals. One of the rewards for the superior's own climb is the right to rule the roost, the right to attention and respect of subordinates. That reward must be partly given up when the manager is asked to set up impersonal objective standards for his subordinates."

**At least five utilities are now considering this new approach seriously.** These are Connecticut Light & Power, Long Island Lighting, Niagara Mohawk Power, Pennsylvania Power & Light, and West Penn Power. Each has refined the basic standards, and plans to try them out if they are well received.

LILCo plans to use its overhead lines department as a pilot installation. Initially, the standards will be used to evaluate progress of line foremen. LILCo thinks it will be ready to give the system a whirl by this fall, and expects some results by early next year. CL&P will try the standards out in its Southern Division "in maybe a month." Reactions there have been encouraging. Supervisors feel it will help them to "know more about what's expected" and ensure that managers and supervisors are "thinking of the same thing."

# Naugatuck PARACRIL OZO

THE OIL-RESISTANT, OZONE-RESISTANT NITRILE RUBBER



## Need **color** in a weather-resistant rubber product?

PARACRIL® OZO will give you all the color you want... any color... permanent, gleaming color for every kind of rubber product, from electric wire to oil pump hose to shoe soles.

Now you can give your product powerful extra selling features... color that attracts, that warns, that identifies, that helps emphasize or hide.

Along with color, PARACRIL OZO gives you a combination of weather resistance, abrasion resistance, oil resistance, flex life and other valuable rubber properties far surpassing conventional weather-resistant rubbers.

See if your product doesn't call for PARACRIL OZO. To find out more about this proven new rubber and the properties it offers your product, contact your Naugatuck Representative or write us today.

**Naugatuck Chemical**

**Division of United States Rubber Company**

813P Elm Street
Naugatuck, Connecticut

Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · CANADA Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · CABLE Rubexport, N Y

*In operation since March, this L&N computer gives Florida Power & Light Co. the desired generation loading pattern on its nine major plants for strict incremental loading, or modified economy loading. The computer can also be used to study anticipated operating problems and their effects on the cost of operating the system while the load control is still in operation.*

# L&N computers close the control loops on 6 major power systems

## *FLEXIBLE NEW COMPUTERS KEEP SYSTEM OPERATION AT OPTIMUM LEVEL OVER WIDE RANGE OF CONDITIONS*

"It's gratifying to know we made the right decision." So said H. W. Page, Manager of Power Supply, Florida Power & Light Co., as he reviewed initial months of operation with his new control. He went on to say, "We know now that as a result of our decision to install this computer, we have advanced the overall level of operating efficiency on our system even more than we expected. The equipment does its job in a thoroughly dependable manner."

Suggestion: you can help *your* system make the move to advanced automatic economy dispatching more objectively—and with confidence—by checking *results* first . . . the actual operating results being obtained right now from California to Carolina, from Connecticut to Florida (names on request). Then contact our local office, or 4938 Stenton Ave., Phila. 44, Pa.

### GET RESULTS ON YOUR SYSTEM WITH AN L&N COMPUTER THAT:

**1.** *Automatically loads generating units on an incremental cost-of-power-delivered basis—includes incremental generating costs and transmission loss factors (transmission loss matrix optional).*

**2.** *Provides real operating flexibility: loads on any desired incremental, or modified economy basis, to meet prevailing system conditions.*

**3.** *Plots "on-the-spot" graphic answers to problems involving economy interchange, power-flow losses or anticipated loading patterns.*

**4.** *Derives a measured lambda value —incremental cost of power delivered—at all times.*

**5.** *Invariably adjusts generation in a direction that reduces area requirement.*

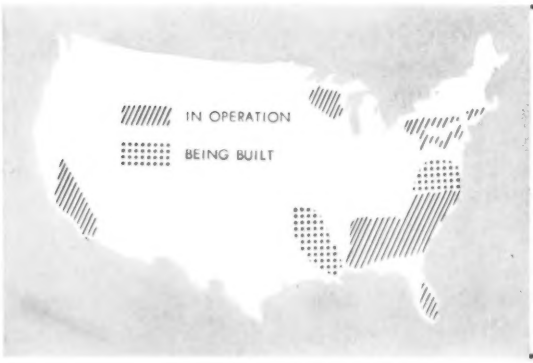
**6.** *Gives each unit a terminal destination.*

**7.** *Makes it easy to place units on control—just flip a switch—no synchronization required.*

**8.** *Provides safety margins: adjustable load limit settings are positive, and cannot be exceeded; maximum rates of control action are positive, adjustable, and cannot be overridden.*

**9.** *Costs less in the long run: requires no unit or governor modifications, goes into service after approximately two to four weeks installation procedure, gives positive assurance against overregulation.*

**10.** *Is easy to operate—gives any desired readout data and, in the opinion of maintenance men, needs relatively little care.*

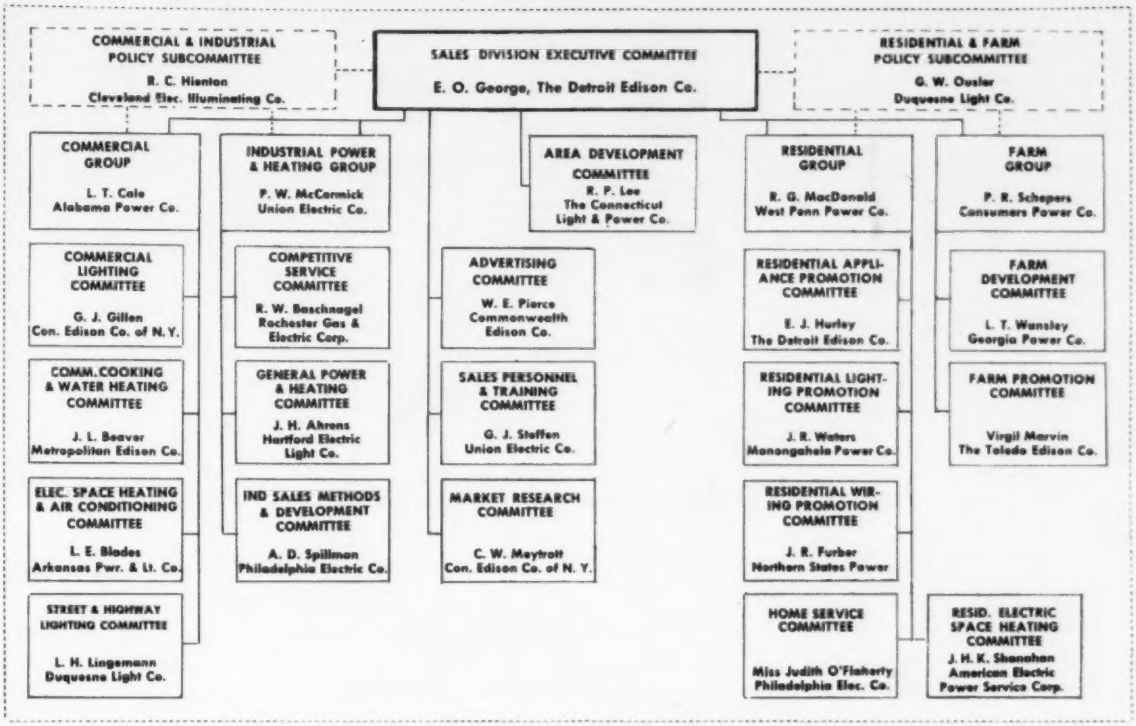



*Already, L&N computers direct the control of approximately 11,000,000 Kw over a large part of the country on systems representing a wide range of operating problems. Shaded area shows territory served by an additional 5,000,000 Kw to be put under L&N computer-control during the remainder of this year.*

**LEEDS NORTHRUP**

"Over 400 automatic generation control installations"

# EEI Sales Division Committee Chairmen Named




## *HEATING & COOLING*

**General Services Administration** in Washington has issued a report which proves that employees work better in air conditioned offices. Work output of employees in air-conditioned space is greater, on the average, by more than 9% than that of employees in similar, non-air conditioned space, the report says. Other findings: A slight decrease in errors (0.9%); a measurable decrease in absenteeism (2.5%); a similar decrease in employee's living expenses due to savings on cleaning bills, hairdos, make-up, etc, and an important, though non-measurable, contribution to employee comfort and morale.

"It is safe to assume," the report states, "that in any other type of office work, where the rate of production is not standardized, or where no minimum requirement must be met consistently, the increase in productivity will be more than enough to pay for air conditioning through savings in employee salaries."

**Electric Heating Assn of Ontario,** the first of its type in Canada, was formed recently. Objectives are to ensure the best possible electrical heating service by standardizing workmanship, design, and operation. A plan to extend similar easy-to-maintain systems into commercial and industrial buildings is also under way.

**Westinghouse Electric Corp** has introduced a new line of electric heating baseboard units. The new line features a three-way air flow design which carries air through the front and rear of the unit. The units have a capacity of 250 w per ft and come in two, four, and six-ft sections.

**More than 5½ million American** homes now have some form of summer air conditioning—an increase of three quarters of a million during the past year, a survey by Carrier Corp shows. The big three are Texas, New York, and Washington, D. C. Texas leads in total households equipped with room or central air conditioning with more than a half million; Washington has more than ⅓ of its households air conditioned; and New York has more than 400,000. Russell Gray, vice president and general manager, Air Conditioning Division, estimates the number of air conditioned homes in U. S. will be almost 12% in 1959.

**Arvin Industries, Inc,** Columbus, Ind., entered the electric home heating field recently, offering a full line of radiant, fan-forced and baseboard heating systems.

FIELD SERVICE ONLY is required for the addition of some new accessories. Here, a Sudden Pressure Relay, preassembled to a new manhole cover, is installed quickly and easily. Relay protects against extensive damage due to internal fault.

# new POWER TRANSFORMER MODERNIZATION PROGRAM CUTS OUTAGES AND COSTS

Helping you cut costs and protect your power transformer investment is the sole purpose of the new Westinghouse Preventive Maintenance Through Modernization Program. It is based on the fact that the best way to reduce outage expense is to replace obsolete parts or add devices in accordance with modern practice. It is organized to provide the exact degree of modernization you need, from simple replacement of parts to complete rebuilding and uprating of transformers.

**Replacement of Obsolete Parts.** Use of modern components to replace outdated parts before they fail will provide a great increase in reliability of units otherwise fit for continued service.

**Use of New Accessories.** The latest developments, such as gas detectors, help solve old operating problems and can be purchased at little cost.

**Addition of Protective Devices.** Equipping your power transformers with modern protective devices assures better continuity of service. Various types relieve dangerous pressures, detect faults and indicate other abnormal conditions.

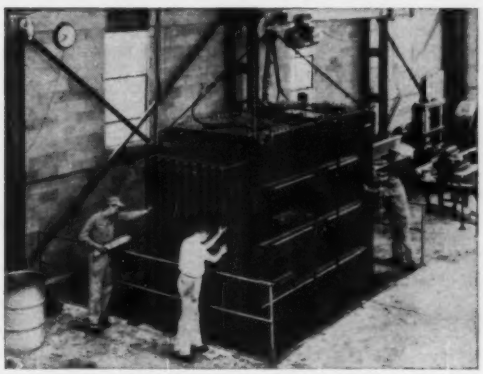
**Oil Preservation Equipment.** Many excellent protective systems can be installed to maintain high dielectric strength of transformer oil.

**Methods to Increase Rating.** Modification of present cooling system permits an increase in rating of older units. Engineering analysis is provided to determine rating increase possibilities.

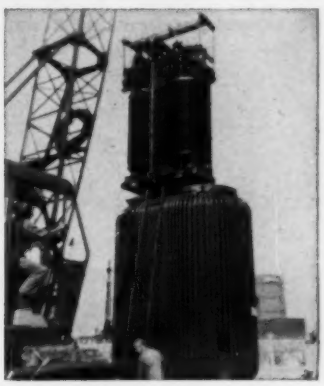
Westinghouse backs this new modernization program with the full facilities and "know-how" of its 40 Manufacturing and Repair Plants throughout the country. Your nearest Repair Plant can provide efficient service in all phases of the program.

Westinghouse field service engineers will be glad to study your power transformers and recommend improvements to increase performance and reliability.

For full information, call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70904



Power transformer is shown being lowered into pit for detanking in a Westinghouse M & R Plant. These plants can perform modernization operations which cannot be undertaken in the field.



Here, Westinghouse service engineers detank a power transformer in the field.

**YOU CAN BE SURE...IF IT'S Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

# Idaho Power Co Elects New Vice Presidents

BALL MOORE EMERY ILCH

Idaho Power Co has elected the following vice presidents: J. F. Emery, H. R. Moore, and R. F. Ball. M. M. Ilch has been named treasurer; H. P. Snyder and E. H. Johnsmeyer, assistant treasurers.

Emery will be responsible for engineering, planning and construction of the company's operating facilities. He was superintendent—electrical operations and construction.

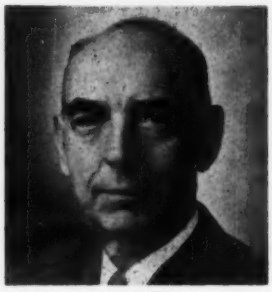
Moore, who was formerly superintendent of power, will supervise power plant operations and coordination of Idaho Power's interconnected system with the Northwest Power Pool. He will also be in charge of the utility's relations with other power pool members.

Ball, assistant to the president since 1952, will be responsible for public and customer relations and will also handle special assignments.

# Four New Vice Presidents Named at Stone & Webster

CLEARY

MC CORD



CUTLER

PRANG

Four vice presidents have been named by Stone & Webster Engineering Corp. They are: Harold F. Cleary and Donald N. McCord, construction managers; M. H. Cutler, engineering manager; and W. R. Prang, West Coast district manager.

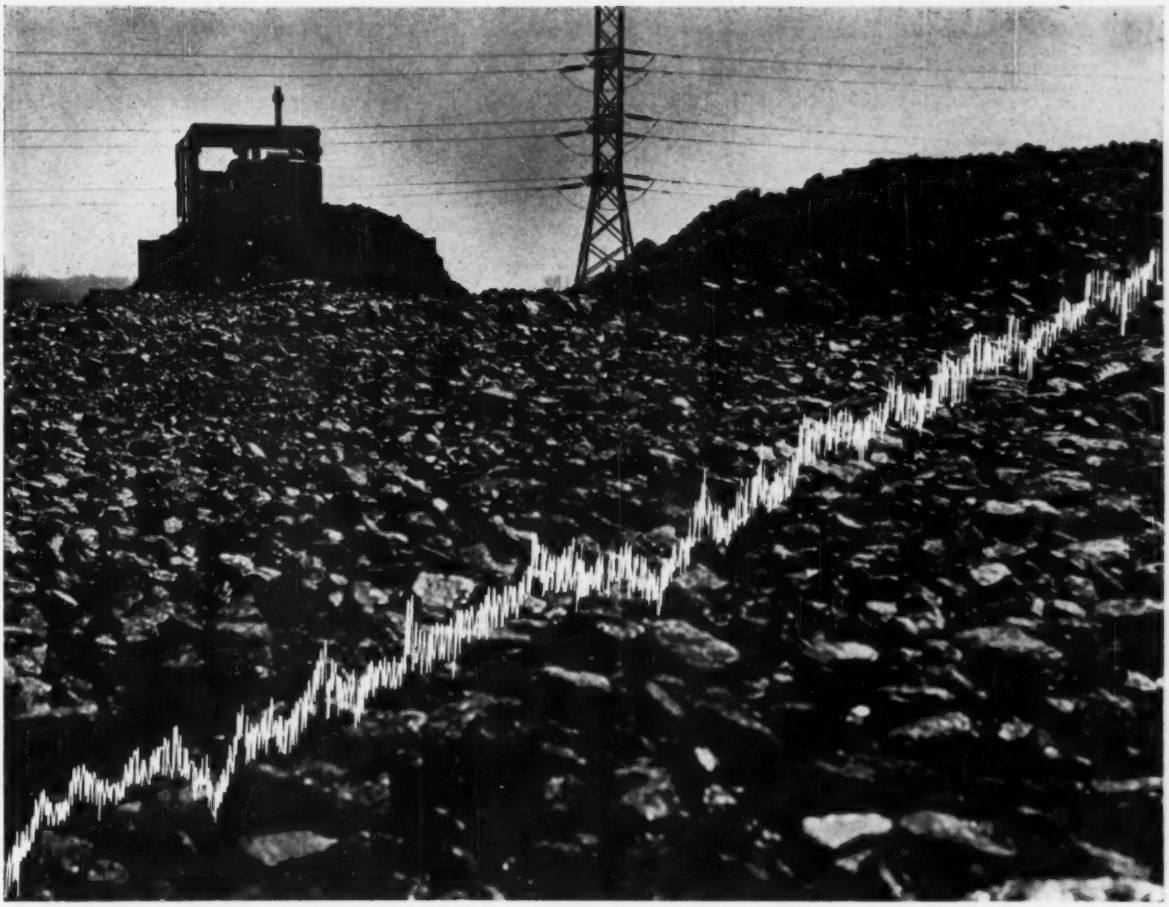
Cleary joined Stone & Webster in 1923 as a field engineer. Since 1934, when he was made construction manager, he has been responsible for construction of industrial and power plant installations in the U. S. and Canada.

McCord has been with Stone & Webster since 1941. Before that he was active in engineering and con-

(*Continued on page* 116)

# powerful reassurance!

In almost every important industrial area, power needs are expected to double again in the next ten years. It is reassuring to utilities, as they plan ahead and build ahead to keep pace with this demand, to know that career coal companies like Island Creek stand ready to deliver the coal needed to generate that power far into decades still uncharted.* Our engineers would welcome an opportunity to talk with yours... about the present... or the future.



*Island Creek's vast, proven, available reserves total more today than Island Creek has taken out of the earth in the past 50 years.*

You can depend on **ISLAND CREEK**

a career company . . . dedicated to coal

Island Creek Coal Sales Company, Chafin Building, Huntington 18, West Virginia • Chicago • Cincinnati • Cleveland • Detroit • Greensboro • New York • Pittsburgh

## LET'S TALK ABOUT STRAND...

# *Aluminized* STRAND

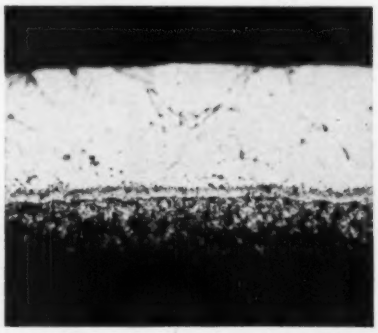
ACCO *Aluminized* steel strand is composed of steel wires which have an adherent, ductile aluminum coating applied by the hot dip method. The result—strand with all the strength of steel, and with the corrosion-resistance of aluminum. Also, you get these important advantages:

**Aluminum oxide protection**—Aluminum, when exposed to the atmosphere, has a film of aluminum oxide formed over it. This film, though thin, is impervious to corrosive atmospheres, provides extra protection in the most severe service.

**Electrochemical protection**—Should nicks or cuts pierce the aluminum coating, the corrosion-resistance will be retained by an electrochemical "healing" process.

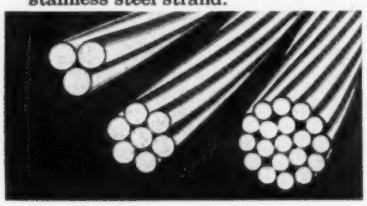
Salt spray tests, conducted according to ASTM procedures, show that with equal thicknesses of coating, *aluminized outlasts galvanized by more than 2 to 1.* Available for guy wire, ground wire and messenger wire applications, Page ACCO Aluminized steel strand is offered in Common, Siemens-Martin, High Strength, Extra High Strength and Utility grades with physical properties conforming to ASTM Spec. A-122-54T and A-363-58.

Page also makes galvanized and stainless steel strand.



500X magnification above shows thin aluminum-iron alloy resulting from diffusion of the two metals, and the outer layer of aluminum in the form of a fine-grain cast structure.

5-year test exposure to industrial atmospheres covered strand with coating of sulfide, oxide and soot. Scrubbing with soap and water showed aluminum coating completely unaffected.



Page ACCO Aluminized steel strand is available with 3, 7 and 19-wire construction.

**WRITE FOR DETAILS.** Booklet DH-537 explains manufacture, properties and uses of Page ACCO Aluminized Steel Strand. Write us at Monessen, Pa., for your copy.

## PAGE MANUFACTURERS WIRE

ACCO

Page Steel and Wire Division
American Chain & Cable Company, Inc.
Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Houston, Los Angeles, New York, Philadelphia, Portland, Ore. San Francisco, Bridgeport, Conn.

### OTHER ACCO ALUMINIZED STEEL WIRES

Aluminized ACSR core wire now available from leading manufacturers of aluminized conductor cable.

Page Chain Link Fence of ACCO Aluminized wire provides economical, longer-lasting protection.

**Tie wire, telephone and telegraph wire, lashing wire, barbed wire, and other products are also available in Page ACCO Aluminized wire. Ask us for details.**

**PAGE** *-the source for answers to wire problems*


struction work in New York and Connecticut for 14 years.

Cutler, who became engineering manager early this year, has done design and consulting work on power stations, industrial and chemical plants, office and institutional buildings in the U. S. and Canada.

Prang joined Stone & Webster in 1931 and has been in charge of the Los Angeles office since 1955. He was a construction superintendent on industrial plants in various parts of this country and Canada for the past 17 years.

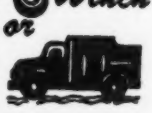
## McCauley Appointed VP at Orangeburg

James E. McCauley has been appointed a vice president of the Orangeburg Manufacturing Co, a division of the Flinkote Co.

McCauley joined Orangeburg in 1947 as assistant to the president. He was later comptroller and has been secretary-treasurer since 1952.

(*More News About People, p* 118)


*Whether a* Winch *Line Hook or a complete Line Body check your requirements with*



**UTILITY TOOL & BODY CO.**

UT&BCo

**CLINTONVILLE, WISCONSIN**

# FOR LOCALIZED SERVICE ON POLE LINE HARDWARE

## SPECIFY CHANCE

Here is the Chance New York ServiCenter, one of ten located from coast to coast.

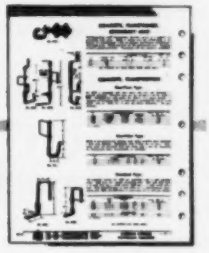
**Thousands of items like these are available for fast delivery.**

Advanced designs in pole line hardware, like the single bolt 808 Guy Guard . . . the new mechanically-wedged fiberglass strain insulator . . . and brand new ideas in brackets and wireholders, as well as standard pole line hardware, are carried in Chance ServiCenter stocks.

## Strategically located Chance *ServiCenters* put stocks and service within easy reach

From anchor to pole top—Chance makes everything you need in guying materials and pole line hardware. Now, ten new ServiCenters put these Chance products within one-day shipping distance of the great majority of Chance customers and distributors. Contact the Chance ServiCenter in your area for prompt quotations, product information, technical assistance and fast delivery.

**The easy way to find pole line hardware information in a hurry . . . Check your Chance "dictionary style" Catalog Pages.**



A. B. CHANCE COMPANY

CENTRALIA, MISSOURI

A. B. Chance Co. of Canada, Ltd., Toronto

CP59-9

"Full-Adjust" Seat

... another reason why

Autocar is the World's Finest

Up or down—forward or back—tilt! At the touch of a lever. This is the comfort of the contour seat in your Autocar cab. It's just one more quality characteristic that makes Autocar the world's finest heavy hauler.

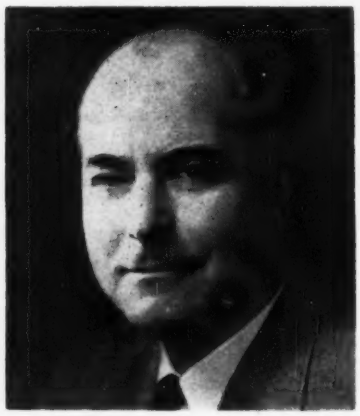
Autocar
"World's Finest"

Division of
The White Motor Company
Exton, Pennsylvania

## Burns & Roe Elects Matiuk VP, Director-Engineering

Burns & Roe, Inc, New York consulting engineers and constructors, has elected Alexander Matiuk vice president and director of engineering.

Matiuk has been with Burns & Roe since 1955, serving first as assistant chief mechanical engineer, and, since 1956, as director, power engineering division.



## Johnson Elected VP and Marketing Manager at RCA

John E. Johnson has been elected vice president and marketing manager, Electronic Data Processing Division, Radio Corp of America.

Before joining RCA last year, Johnson was marketing vice president of the Datamatic Division of Minneapolis-Honeywell Regulator Co. For nine years he was associated with Ernst & Ernst as a management consultant, and before that was with the Burroughs Corp.

new... DAVIS PUP
SELF-PROPELLED
UTILITY TRENCHER

ONLY $495.00
F. O. B. FACTORY

digs by itself!

The all-new Davis Pup is completely self-propelled by 6-speed winch drive. Ditches — without constant supervision — while you prepare material for trench. Digs 2" to 3" wide down to 3' deep... does not damage surrounding turf. Has positive depth control adjustment and interchangeable booms and digging chains. Gasoline or electric powered. A truly remarkable trenching tool... fully guaranteed. Pound for pound... dollar for dollar... your best buy by far. Write for free literature and name of your nearest distributor.

DAVIS MFG. INC.
1301 S. HANDLEY • WICHITA 13N, KANSAS

NEW 3/4-ton Pull-A-Way
Added to WRIGHT TYPE "C" LINE!

FOUR SIZES • ¾, 1½, 3 and 6 Tons

FEATURES
• Lubricated for life
• Hooks are drop-forged
• Special alloy-steel chains
• Chain sheaves of drop-forged alloy steel
• Gear teeth cut to precision limits
• Load brake is dependable and safe
• Weights:
¾-ton, 14 lbs.
1½-ton, 23½ lbs.
3-ton, 36½ lbs.
6-ton, 63 lbs.

New 3/4-ton model
• VERSATILE
• LIGHTWEIGHT

ACCO

Write to York, Pa., office for complete information

Wright Hoist Division
AMERICAN CHAIN & CABLE
York, Pa., Bridgeport, Conn.

## PERSONAL BRIEFS

**Geoffrey L. Haszard,** general purchasing agent of British Columbia Electric Co, has been elected president of the Electrical Service League of British Columbia, succeeding **S. V. Grisdale,** Canadian General Electric Co district manager.

**Mayor Harold P. Saueressig** of Artesia, New Mexico, has been appointed a member of the New Mexico Public Service Commission.

**A. A. Bradley,** recently retired as business manager and financial secretary of Local 76, International Brotherhood of Electrical Workers has been appointed to the Tacoma City Council as a member of the Utility Board.

**Dr George T. Harness** has been named Dean of Engineering and Science at the new San Fernando Valley State College in Northridge, Calif.

Commissioner **Ralph L. Fusco** has been named president of the New Jersey Board of Public Utility Commissioners by Gov Robert B. Meyner.

**Daniel Sprague** has been appointed to a two-year term as a member of the Manitoba, Canada, Hydro-Electric Board.

**Malcolm F. Judkins** has been appointed technical director, commercial production engineering of Sylvania-Corning Nuclear Corp.

**William J. Auger** has been appointed sales promotion manager of D. W. Onan & Sons Inc.

**Robert A. Strain** has been named manager of utility relations for the Maytag Co.

Kerite Co has made these title changes: **Lee W. Eighmy** to technical assistant to the president; **William A. Edwards** to eastern railroad sales manager; **C. A. Lundy** to eastern power sales manager; and **J. H. Cowan** to Philadelphia district manager.

(*More News About People on p* 120)

LGP-30

ROYAL PRECISION

**Electronic digital computer permits load-flow calculations on networks of up to 100 busses and 270 lines at lowest cost**

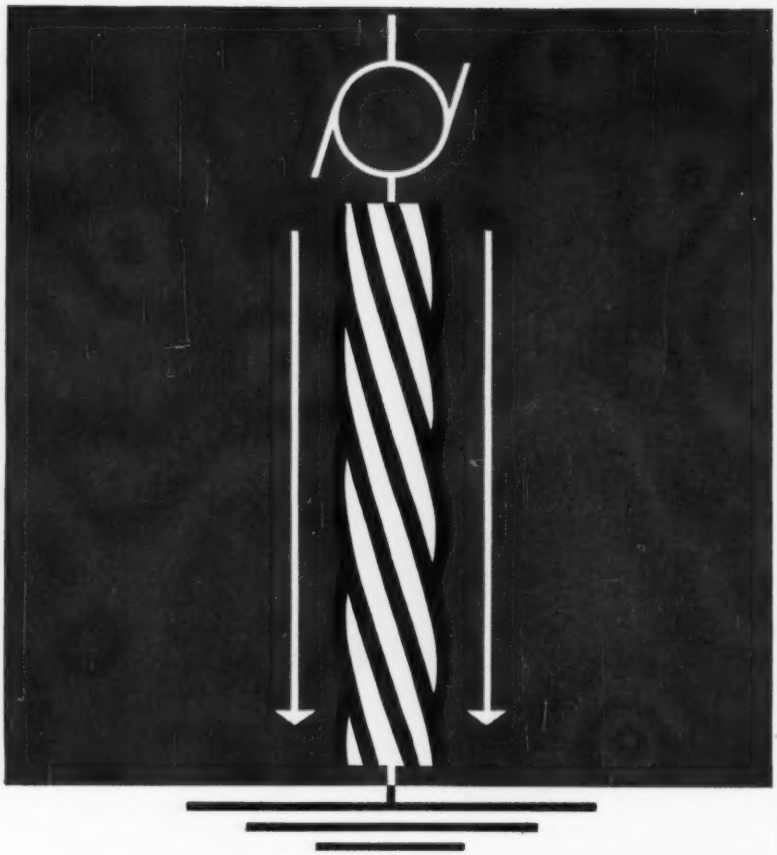
**Gives you optimum level efficiency in production, sales, purchase!**

The lowest-priced complete computer you can buy, the versatile LGP-30 saves you time and money by 1) economically solving your load-flow problems; 2) forecasting optimum turbine-generator and boiler usage under varying conditions of system demand; 3) optimizing purchase and sales of power.

Now at work serving numerous electrical utilities, the compact, mobile LGP-30 operates from any convenient wall outlet . . . requires no expensive air-conditioning or installation. It gives you twice the capacity of any computer in its class, yet is by far the easiest to program in basic machine language.

Internal components of the LGP-30 have been greatly reduced to insure highest reliability. Operation has been remarkably simplified. Your personnel are quickly trained by Royal McBee without charge. Sub-routines and programs are available — as well as membership in an active users organization. Sales and service facilities are maintained coast-to-coast. For further information and specifications, write Royal McBee Corporation, Data Processing Division, Port Chester, N.Y. In Canada: The McBee Company, Ltd., 179 Bartley Drive, Toronto 16.

ROYAL McBEE · *data processing division*



*It's safe... it's grounded with*

## CF&I Galvanized Steel Strand

When grounding electrical installations, you can't afford to use "second best" wire. Insist on a dependable steel strand that will give years of trouble-free service — CF&I Galvanized Steel Strand. Woven in seven- or three-wire constructions, CF&I Galvanized Steel Strand is made in accordance with ASTM Specification A-363 zinc coated steel Overhead Ground-Wire Strand.

For guy, messenger and other applications we recommend ASTM Specification A-122. *CF&I is also prepared to produce uniformly galvanized strand to your own specifications.*

Remember . . . for quick delivery and complete information, call the nearby CF&I sales office or your local electrical distributor.

**GALVANIZED STEEL STRAND**
**THE COLORADO FUEL AND IRON CORPORATION**

*In the West:* THE COLORADO FUEL AND IRON CORPORATION — Albuquerque · Amarillo · Billings · Boise Butte · Denver · El Paso · Farmington (N. M.) · Ft. Worth · Houston Kansas City · Lincoln · Los Angeles · Oakland · Oklahoma City Phoenix · Portland · Pueblo · Salt Lake City · San Francisco San Leandro · Seattle · Spokane · Wichita

*In the East:* WICKWIRE SPENCER STEEL DIVISION — Atlanta · Boston Buffalo · Chicago · Detroit · New Orleans · New York · Philadelphia

CF&I OFFICE IN CANADA: Montreal

CANADIAN REPRESENTATIVES AT: Calgary · Edmonton · Vancouver · Winnipeg

6988

**Samuel M. Arnow** has joined C. H. Wheeler Manufacturing Co as consulting engineer.

Federal Pacific Electric Co has made these changes: **Robert J. Wyllie,** formerly with the General Electric Co, has been appointed advertising and sales promotion manager. **Leonard P. Shelley** has been made manager of the Pacific Switchgear Division and **Robert L. Lemman** to manager of the Pacific sales region.

Two appointments of executive personnel have been announced by the Blaw-Knox Co. **George E. Kopetz,** vice president of production, has been named vice president and general manager of the newly formed fabricating, engineering, and construction group. **Arthur E. Murton,** formerly roll sales vice president, has been appointed vice president and general manager of the new foundry and mill machinery group.

## OBITUARY

**William Jennings,** 66, recently recently retired assistant to the chief engineer, Utah Power & Light Co, on July 9 . . . **Fred L. Higgins,** 62, commercial sales representative for the Florida Power & Light Co, on July 2 . . . **Curtis M. Colvin,** director of advertising, Duquesne Light Co . . . **James A. Batcheldor,** 64, retired district superintendent of the Northern Indiana Public Service Co, on July 9 . . . **Vard Hannum,** 76, superintendent of the Anaheim, Calif., Light, Water, and Power Department . . . **Hugo W. Wahlquist,** 63, a corrosion engineering consultant with Ebasco Services Inc, on July 9 . . . **Thorsten A. Fjellstedt, Sr,** 61, manager of power switching engineering for Line Materials Industries, McGraw-Edison Co . . . **Carleton B. Smith,** 63, director of service for Allis-Chalmers Industries Group, on July 6 . . . **Jimmy F. Hitchcock,** commissioner of the Alabama Public Service Commission . . . **Herman Koenig,** 65, member of the board of Electrical Testing Laboratories, Inc, on July 6.

(*More News About People, p* 124)

***Chevy shows its stamina on tough electric utility runs***

# "Chevy Trucks *stay* on the job, keep our costs low, no matter what!"

— W. B. STREITLE
ASST. SUPT. OF TRANSPORTATION
ROCHESTER GAS & ELECTRIC CORP.
ROCHESTER, NEW YORK

"After many years of experience, we have found that Chevrolet trucks have the stamina and ability to uphold our reputation among customers for being 'always at your service.' In our northern climate, we are faced with an unusually rugged winter operation that includes lots of snow, ice, cold weather and salted streets. We've found that Chevrolets *stay* on the job and keep our costs low, no matter what the conditions.

"We feel that sound maintenance practices and favorable operating costs are a contributing factor in rendering a superior type of service to our customers."

Chevy, you'll find, is winning a lot of new boosters among electric utilities, for a number of good reasons. Reasons like money-saving *power*, for instance. Chevrolet for '59 offers newly improved valve-in-head 6's that nurse a gallon of gas like nothing in trucks has before. Or big V8's for every Series which include the shortest stroke design — the best saving design — in the field. And Chevy's tough chassis components are specially designed for the capacity to out-muscle the roughest kind of runs. For the *latest* in low-cost hauling equipment, see your Chevy dealer! . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

CHEVROLET

## No job's too tough for a Chevrolet truck!

# Plan '59

## *To modernize now for growth and profits*

# Goes Into High Gear

**In 1959, industry will spend more money than ever before to modernize its plant and equipment. But it is not spending enough to do the job that needs to be done.**

Manufacturing companies* now plan to spend a total of $24.5 billion on modernization in the four years 1959-1962. This will be enough to replace roughly 70% of the obsolete facilities that were on hand at the beginning of 1959. But it will still leave us far short of our goal. It would take several years, at a higher rate of investment than is now planned, to wipe out obsolescence and give the U. S. a truly modern industrial plant.

These facts stand out from the 12th annual Survey of Business' Plans for New Plants and Equipment just completed by the McGraw-Hill Department of Economics. This new survey shows that industry has made a remarkable start on the modernization job that a previous editorial in this series described as "the most expensive task to be performed in America in this new year of 1959." The full cost of modernization has been found by the McGraw-Hill Department of Economics to be $33.3 billion for manufacturing, and $95 billion for all business.

For the past several months, McGraw-Hill publications have been devoting special attention to new developments in plant and equipment that offer opportunities for modernization. Our special effort to help industry in this regard has been called "Plan '59": to modernize *now* for growth and profits. This editorial will summarize the progress made so far with "Plan '59" and point out some of the areas where business and public policies can do still more to accelerate the modernization drive.

### A Good Start

**Business investment in new plant and equipment has picked up sharply since the low point of the 1958 recession. Plans for 1959 now show a 7% increase over 1958 for total capital investment. And the increase in expenditures for modernization is much sharper.** Moreover, companies already have substantial plans for the years after 1959. New orders for industrial machinery, which are a good index of modernization plans, also are running well ahead of last year.

For the four-year period 1959-1962, manufacturing companies expect, on the average, to devote 65% of their plant and equipment outlays to modernization. This is the highest proportion reported in a McGraw-Hill survey since 1950. In dollar terms, manufacturing companies plan to spend $24.5 billion on modernization during the next four years.

This is an impressive figure, but it does not look so large when compared with the total need

*Excluding petroleum refining, which is reported as part of the oil industry in the data discussed in this editorial.

for modernization in manufacturing industries. As noted above, a previous McGraw-Hill study (conducted in August 1958) found that it would cost almost $35 billion to replace all the facilities that manufacturing companies then considered obsolete. Thus, present plans for modernization are enough to wipe out only 70% of the backlog of obsolete facilities by 1962—and this makes no allowance for the additional facilities that will be made obsolete by new machines and new processes introduced during the next four years. When these new developments are considered, present plans for spending may represent only half the job that will actually need to be done.

## How To Accelerate

What can be done to accelerate the drive to modernize our industrial plant and equipment? Two of the greatest aids would be:

**(1) Improve present provisions under the tax law for depreciation, to help industry retain more of the money it needs to carry out this massive job of modernization;**

**(2) Contain inflation, to preserve the purchasing power of the money industry sets aside to replace obsolete facilities.**

At first glance, the supply of funds from depreciation allowances appears to be more than adequate. For manufacturing as a whole, depreciation allowances—the primary source of cash for modernization—will total $8.3 billion in 1959, compared with present modernization plans of $6.4 billion. Thus some extra funds will be available to support a further step-up in modernization in 1960.

Unfortunately, however, these depreciation funds are not evenly distributed from industry to industry, or from company to company. For example, in several of the metalworking industries, the prospective flow of cash from depreciation during the next four years is much less adequate than for manufacturing as a whole. These are industries with relatively large modernization backlogs, and they also are industries made up mostly of small or medium-size companies that have difficulty tapping the public money market.

As a result of these industry and company differences, there are many individual cases where shortages of funds limit the amounts of modernization now planned. In the McGraw-Hill survey, nearly half of all companies participating said that they would spend more on new plants and equipment if the depreciation allowances permitted by the tax law were increased substantially over the next few years. Most of these were relatively small companies. Their answers suggest that revision of the tax rules on depreciation should receive the most careful consideration as a spur to faster modernization.

The problem is complicated also by the threat of further increases in the national price level, which would necessarily include prices of capital goods. If "creeping inflation" resumes its march during the next four years, depreciation allowances based on present costs will be much less adequate for future needs. This points up the importance of national economic policies to maintain price stability. Unless this can be maintained, industry's dollars will not go far enough to do the modernization job that is needed.

## Plan '59 Carries On

**Industry's drive to modernize is now well underway. It can make a key contribution to our national strength and prosperity in 1959 and the years ahead. But the biggest part of this job is before us. It is up to the policy makers—in both business and government—to see that the job is done.**

*This message was prepared by the McGraw-Hill Department of Economics as part of our company-wide effort to report on opportunities for modernization in industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.*

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

## SALES ASSIGNMENTS

COMPANY STAFFS

**Line Material Industries** of the McGraw-Edison Co has made Stanley D. Reed apparatus engineer in Portland, Ore.; Wayne C. Wiechmann will succeed Reed as field engineer in Chicago, Ill., and Ernest E. Thompson has been assigned the duties of field engineer at Minneapolis, Minn.

**Sylvania Lighting Products,** a division of Sylvania Electric Products, Inc, has appointed George W. Ross as Milwaukee district sales manager.

**Exide Industrial Division** of the Electric Storage Battery Co has named William E. Carter as branch sales manager in the Pittsburgh area.

**I-T-E Circuit Breaker Co** has moved its western regional office from Denver to San Francisco. The San Francisco office is located in the Rialto Building, Room 106, 116 New Montgomery Street, and covers an 11-state territory which include California, Oregon, Washington, Arizona, Utah, Nevada, Idaho, Montana, Wyoming, Colorado, and New Mexico. The Denver office, 655 Broadway Building, will continue to serve as a district office.

**Day-Brite Lighting, Inc,** has appointed Cecil L. Cannon as Southern regional sales manager.

**Westinghouse Electric Corp** has named Gordon V. Wahlin manager of the Detroit district of the Westinghouse Appliance sales. He will be headquartered in Detroit, Mich. Company has appointed Rex N. Anderson as sales manager. His sales area, being based in Salt Lake City, Utah, will include the state of Utah, southern Idaho, eastern Oregon, western Wyoming, and northern Nevada.

**Worthington Corp** has appointed Fred O. Snyder as manager of the district sales office in Cincinnati, Ohio, succeeding Ralph G. Griffin who has been transferred to the company's Harrison, N. J. office.

**Leeds & Northrup Co** has promoted William C. Roxby to manager of the Foreign Sales Division.

## Cites Compensation Law Change

(*Continued from page* 48)

vision certainly contributed to the 55% of fatal cases caused by men forgetting or ignoring the use of rubber gloves. The much higher percentage of foot and leg contacts, he said, indicates improper training and supervision in the use of rubber goods, wooden platforms, etc. He cited results obtained in his company since adoption of a "get tough" policy:

**1.** A mandatory sleeve rule, adopted in 1952, requires that sleeves be worn whenever gloves are required. Compared with an average of 15 to 20 cases per year, only four cases of shock or burn occurred since 1952, and these could have been prevented by sleeves.

**2.** A mandatory electric hard hat rule, adopted in 1955, has prevented almost certain death to four people. Based upon compensation costs, Potomac Electric has paid for the hats and is several hundred thousand dollars to the good.

**3.** Mandatory use of goggles, complete inspection of line trucks on a continuous basis, and other routine safety measures have reduced injuries considerably.

Recommendations of the committee, describing accident statistics over the years and appealing for support, will be submitted by letter to utility presidents, said J. R. Hanford, Public Service Electric & Co. A monthly statistical report will be sent to the safety supervisor of each company, and monthly releases will be prepared for his use. Practice booklets will be assigned for preparation to members of the safety package committee and made available at the next meeting for review, reported R. E. McCann, So Cal Edison.

The film "Pole Top Pals" will be available soon in a revised issue, reported L. A. Westrom, Bureau of Safety, speaking for J. W. Gronbeck. Changes and additions will cover the use of hard hats, sleeves, connector line hose, lineman's platforms, split blankets, dead-end protectors, and especially the proper working position of linemen.

The committee passed a resolution to adopt mouth-to-mouth resuscitation, a decision following much discussion led by W. C. Bremmer, Commonwealth Edison Co.

Experiments to counteract fibrillation by electric shock proved successful on dogs at Johns Hopkins University, reported Dr. W. B. Kouvenhoven and Guy Knickerbocker. Although early tests were conducted with 440 v at 60 cps for short periods, a 24-lb, battery-operated, portable unit is now used.

New tools have been developed to help linemen work safely.

Conductor cleaning brush guards were described by I. R. Dohr. A high-voltage detector, replacing the glow-stick, is now available for circuits below 15 kv, according to R. W. White, PG&E. Among special tools developed at New Orleans Public Service, are a flashlight on a switch stick, a dummy cutout fuse barrel, and an insulated line to pull a residential distribution line aside from tree branches until crews can clear the line conveniently, said Arthur J. Naquin, who is the committee's new chairman.

## 'Superman' Approach

At about the same time that the EEI Accident Prevention Committee was recommending approval of the mouth-to-mouth method of artificial respiration in Los Angeles last fortnight, Alvin Lee Lawrence was using the technique to save a 22-month old boy. Lawrence, a Cincinnati Gas & Electric Co meterman's assistant, heard the screams of the boy's mother when she found the lad turning blue in a wading pool. Lawrence came running, bounded over several fences like "Superman," as she recalled, and administered aid.

## B. C. Power Cuts Back

Completion of such multi-million dollar projects as the Stratchcona development, the Georgia plant and the Ash River scheme has caused a reduction in engineering and planning staffs of the government-owned B. C. Power Commission. Twelve men have been laid off and the total is expected to reach 50 by the end of the year.

## –PROFESSIONAL SERVICES–

**BLACK & VEATCH**
*Consulting Engineers*
Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction
Investigations, Valuations and Rates
1500 Meadow Lake Parkway
Kansas City 14, Missouri

**THEODORE D. BROSS**
**LINE CONSTRUCTION CORP.**
Steel Tower & Wood
Transmission Lines
*Distribution & Maintenance*
175 Enfield St. Hartford, Conn.

**COMMONWEALTH SERVICES INC.**
Management and Business Consultants
300 Park Ave.
New York 22, N. Y.

**ASSOCIATES INC.**
Consulting and Design Engineers
209 E. Washington
Jackson, Michigan

**ELECTRICAL TESTING LABORATORIES, INC.**
Electrical, Electronic, Environmental, Photometric and Chemical Laboratories, Testing, Research, Inspection and Certification.
2 East End Ave. New York 21, N. Y.

**HOOSIER ENGINEERING COMPANY**
*Erection and Maintenance of*
*Electrical Transmission and Distribution Lines*
1350 Holly Ave., Columbus 16, Ohio

**JENSEN, BOWEN & FARRELL**
*Engineers*
Appraisals—Depreciation Studies—Property Records
Cost Trends—Special Studies—Reports for Rate Cases, Security Issues, Regulatory and Accounting Requirements
Michigan Theatre Building Ann Arbor, Michigan
NOrmandy 8-7778

**PIONEER SERVICE & ENGINEERING CO.**
Consulting and Design Engineers . . Purchasing
Specialists in Financing
Accounting and other Operations
231 So. La Salle St. Chicago 4

**SANBORN MAP COMPANY**
*Nation Wide Mapping Services*
• Utility Area Base Maps
• Symbolized System Portrayal
Atlanta - New York - Chicago - San Francisco

**SARGENT & LUNDY**
*Engineers*
140 South Dearborn St.
Chicago, Ill.

**TIPPETT & GEE**
*Consulting Engineers*
Mechanical • Electrical • Thermodynamic
Structural Design • Studies • Supervision
Power Stations • Transmission • Distribution
Industrial Plants • Process
1233 North Second Street Abilene, Texas

# SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT: BUSINESS: **"OPPORTUNITIES"** EQUIPMENT USED OR RESALE

*ADDRESS BOX NO. REPLIES TO: Box. No.*
*Classified Adv. Div. of this publication.*
*Send to office nearest you.*
*NEW YORK 36: P. O. BOX 12*
*CHICAGO 11: 520 N. Michigan Ave.*
*SAN FRANCISCO 4: 68 Post St.*

### POSITIONS VACANT

**City Electrical Superintendent, Idaho Falls,** Idaho. An administrative position requiring design, supervision, construction and maintenance of a power system serving nearly 10,000 metered customers. The present Electrical Dept. includes approximately 40 employees. This employee shall hold a key position in the administrative staff during the dynamic growth of Idaho's 2nd largest community. All applications must be submitted in writing, and all inquiries and replies are confidential. State the salary expected and address all applications to the City Engineer, Idaho Falls, Idaho.

**Supervisor—Engineer transmission dept.** small G & T system. Man with technical education, qualified or with development potential, to supervise operation, maintenance and expansion lines, subs, metering, supervisory control carrier, relaying & related central station equipment. Small town location in recreation & outdoor sports area. State qualifications, experience & salary requirements. Replies confidential. Northern Michigan Electric Cooperative, Boyne City, Mich.

**If you are a graduate Electrical Engineer** interested in varied and challenging work, if you have had some experience in power systems operations, or relay equipment, contact Personnel Department, Rural Cooperative Power Association, Elk River, Minnesota Top fringe benefits, permanent position.

**Graduate Electrical Engineer wanted by rapidly** growing electric utility in Pacific Northwest serving approximately 55,000 customers. Desirable qualifications of applicant would include experience in distribution and transmission line design, line and transformer loading studies, distribution conversions to higher voltage, fuse and circuit breaker coordination studies, or substation design, construction and operation. When replying, please give complete details of education and other qualifications, salary expected and when available. P-2274, Electrical World.

### SELLING OPPORTUNITY OFFERED

**Representative wanted for manufacturer of** street lighting equipment, pole line specialties. Full particulars. RW-9821, Electrical World.

### POSITION WANTED

**Electrical Engineer, B. S. E. E. (Power), 33, with 6 years experience in all phases of the** design of high-voltage substations and switchyards would like to do engineering design work in this field with a progressive organization. PW-2198 Electrical World.

*Don't forget the*

**BOX NUMBER**

**When answering the classified advertisements in this magazine don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.**

## CHIEF ENGINEER

**Challenging opportunity in newly established Division of Multi-Plant Company.**

**Supervise 40 man Engineering Section responsible for Molded Case and other Circuit Breaker Design and Development.**

**Graduate Electrical Engineer with wide experience in general fields of Control or Distribution.**

**Location—Cedar Rapids, Iowa Salary to $18,000**

**Company will pay placement fees and moving expenses.**

P-2228, Electrical World
520 N. Michigan Ave., Chicago 11, Ill.

## SALES ENGINEERS

**Growing, multi-plant manufacturer of power and communications line equipment has openings for sales representatives. Territories open in Illinois, Michigan, New York, and Texas. Men we are looking for must have EE degree or equivalent and successful sales or related experience. Salary based on qualifications. Annual bonus, profit sharing, merit increases. Car and expenses furnished. Replies confidential. Send resume of age, education, experience to Box**

P-2064, Electrical World
520 N. Michigan Ave., Chicago 11, Ill.

## ELECTRICAL ENGINEERS

**With 3 or more years experience in electrical design for buildings, including lighting, distribution, wiring, etc. Permanent employment with well-established midwestern consulting engineering firm. Write giving personal resume and required salary.**

P-2286, Electrical World
520 N. Michigan Ave., Chicago 11, Ill.

**TRANSFORMERS**
**1—6000 kva G.E. 3/66000/2400/4160Y**
**1—2000 kva Nia. Askarel, 3/13800/4160Y/2400**
**3—1000 kva Westinghouse, 1/22900/480**
**3—1000 kva Westinghouse, 1/13800/480**
**3—1000 kva Westinghouse, 1/13800/2400/4160Y**
**3—1000 kva Standard, 1/44000/6900**
**3—1000 kva Standard, 1/69000/4160Y/2400**
**3—1000 kva Standard, 1/34400/480**
**ERIE ELECTRIC CO. INC.**
**26 Mechanic St. Buffalo 2, N. Y.**

### MANAGER WANTED

Manager for a progressive rural electric cooperative located in the northwestern part of Arizona. Permanent position carrying substantial opportunity for qualified person. Replies confidential. Applicants write for REA Form 328, which can be obtained through: **Russell Martin, President**
**Mohave Electric Cooperative, Inc.**
**P. O. Box 711, Kingman, Arizona**
*Closing date of applications, August 24, 1959.*

**MOTORS • GENERATORS**
**TRANSFORMERS**
NEW • REBUILT
**ELECTRIC EQUIPMENT CO.**
WORLD'S LARGEST INVENTORY
CALL COLLECT GL 3-8783
P O BOX 51 • ROCHESTER 1, N Y

**New and Used Equipment Available for**
**POWER PLANTS, SUBSTATIONS, TRANSMISSION LINES AND CONSTRUCTION**
*Send for new list to*
**EBASCO SERVICES INCORPORATED**
**APPARATUS EXCHANGE** **Two Rector St., New York 6, N. Y.**

# Readers Forum

### Any Battery-Driven Mowers?

To the Editor:

I was interested to see in the March 16th edition of Electrical World, your editorial reference to the creation of an "Electrical Dreamers' Club" and I would very much like to know whether you received any worthwhile reactions to your inquiry for information relative to the development and/or availability of a battery-driven lawn mower.

The desirable features of such a piece of machinery are obvious as are some of the difficulties and it would be interesting to know if your initial shot found a target.

L. Baldwin
Executive Engineer
Electrical Metering Division
Emmco Pty. Limited
Waterloo
N.S.W. Australia

*Sorry. Not yet.*

### Even the Gas Lights Help

To the Editor:

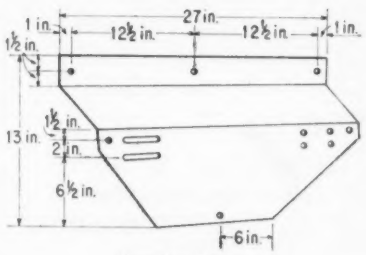
I read with interest your editorial entitled "Gas Lights Must Go!". All coins have two sides and I thought that you might be interested in my version of the other side of this particular coin.

I live on an unlighted deadend street. Last June I installed a gas yard light and we like it very much. It burns 24 hours per day and most certainly provides high load factor gas load. The interesting thing, at least it should be to you, is that since we installed this light our neighbors who all have either electric yard lights or porch lights have been prone to use their electric lights, something they never did before we installed our light. The ratio is at least three to one.

There are many thousands of electric yard lights installed all over the country and in most instances these are used either when company is coming or someone in the family is expected to return home late in the evening. As you already know, the spirit of "keep up with the Joneses" has become almost a principle in the American way of life and if what I say is true, I believe you do the electric industry a disservice in your attitude, for what good are yard lights if they are not in use. Time will tell whether gas yard lights are a fad, but fad or not, every gas yard light that is lit 24 hours a day will encourage the use of the tremendous numbers of electric yard lights already installed and, in my opinion, promote the installation and particularly the use of yard lights.

With best regards for the continued success of your most excellent magazine, I am

J. R. Delaney, Manager
Gas Sales
The Cincinnati Gas & Electric Co.
Cincinnati 1, Ohio



Mounting Plate

### Universal Mounting Plate

To the Editor:

The drawing illustrating the pothead mounting plate described on page 168 of your June 29, 1959, issue is in error. A correct sketch, with necessary dimensions, is enclosed (see above).

J. P. Clyde
Senior Engineer
Commonwealth Edison Co
1319 S First Ave
Maywood, Ill.

## Advertising Index


Air Preheater Corp. ..... 35
Allen-Bradley Co. ..... 83
Allied Chemical Corp., Baker & Adamson Prods, General Chemical Div. ... 30
Allis-Chalmers Mfg. Co. ....25, 27, 28, 29
American Chain & Cable Co., Inc.
Page Steel & Wire Div. ..... 116
Wright Hoist Div. ..... 118
American Creosoting Corp. ..... 21
Automatic Switch Co. .....72, 73

Bechtel Corp. ..... 10
Bethlehem Steel Co. ..... 26
Blackburn Corp., Jasper ..... 32
Blaw-Knox Co. ..... 23
Buffalo Forge Co. ..... 8
Burndy Corp. ..... 103
Bussmann Mfg. Div.,
McGraw-Edison Co. .....98, 99

Chance Co., A. B. ..... 117
Chevrolet Div. General Motors Corp. . 121
Colorado Fuel & Iron Corp. ..... 120
Cornell-Dubilier Electric Corp. ..... 33

Davis Mfg. Co. ..... 118
Directory of Engineers ..... 125

Electric Controller & Mfg. Co. ..... 86
Engineers, Directory of ..... 125

G&W Electric Specialty Co. ..... 77

General Electric Co.
Apparatus Dept. ..2nd Cover, 6, 50, 51, 52, 53
Insulator Dept. .....11, 12
Graybar Electric Co., Inc. ..... 7
Grinnell Co., Inc. ..... 97

Husky Products, Inc. ..... 61

I-T-E Circuit Breaker Co.,
Victor Insulators Div. ..... 55
International Business Machines Corp. ..... 20
Island Creek Coal Sales Co. ..... 115

Lapp Insulator Co., Inc. ..... 80
Leeds & Northrup Co. ..... 110
Line Material Industries .....17, 18, 19

McCabe-Powers Body Co. ..... 4
McGraw-Hill Book Co., Inc. ..... 64
Mine Safety Appliances Co. ..... 31
Moloney Electric Co. ..... 40

National Electric Coil Div.
McGraw-Edison Co. ..... 93

Okonite Company .....60, 85
Orchard Industries, Inc. ..... 9

P-W Industries, Inc. ..... 63
Page Steel & Wire Div.,
American Chain & Cable Co., Inc. ... 116
Paranite Wire & Cable Div.
Essex Wire Corp. ..... 24
Pennsylvania Transformer Div.
McGraw-Edison Co. .....88, 89

Reynolds Metals Co. .....38, 39
Rome Cable Dept. .....78, 79
Royal McBee Corp. ..... 119

S&C Electric Co. ..... 104
Searchlight Section ..... 125
Simplex Wire & Cable Co. .....3rd Cover
Southern States Equipment Corp. .36, 37
Square D Co. ..... 71
Subox Inc. ..... 62

United Engineers & Constructors, Inc. ..... 34
United States Rubber Co. ..... 109
Utility Tool & Body Co. ..... 116

Wagner Electric Corp. ..... 58
Westinghouse Electric Corp. .22, 94, 95, 112, 113
White Motor Co. ..... 118
Worthington Corporation .....4th Cover
Wright Hoist Div.,
American Chain & Cable Co., Inc.. 118

PROFESSIONAL SERVICES ..... 125

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES .... 125

EQUIPMENT
(Used or Surplus New)
For Sale ..... 125

# Simplex PRODUCTS GUIDE

SIMPLEX WIRE & CABLE CO., CAMBRIDGE 39, MASSACHUSETTS, U.S.A.

**Simplex ANHYDREX Insulated Cables** for Power transmission and Communication (like the Simplex TIREX Portable Cords and Cables shown in adjacent column), though manufactured as stock products, are custom designed to suit all service requirements. A large technical and engineering staff at Simplex' main plant is equipped to give you the benefits of their long experience in electrical cable planning.

**ANHYDROPRENE** — Simplex ANHYDROPRENE Cables are designed for economical installation in ducts, conduits, racks, trays and raceways. Stock sizes AWG 14 to 1000 MCM are recommended for 90 C service in WET or DRY locations. The words "Simplex ANHYDROPRENE" are either printed or molded plainly on the jackets of all ANHYDROPRENE cables. This marking signifies the traditionally high quality of a Simplex product.

**CATALOGUE #1028**

**ANHYDREX-NEOPRENE** — Simplex ANHYDREX-NEOPRENE Cables have the added mechanical protection of a heavy wall of neoprene jacketing. These cables are manufactured for use in aerial installations and for direct burial service. Stock sizes AWG 14 to 1000 MCM are recommended for 90 C service in WET or DRY locations.

**CATALOGUE #1028**

**ANHYDREX-PLASTEX** — Simplex ANHYDREX-PLASTEX (ANHYDREX-insulated, PLASTEX-jacketed) Cables are scientifically designed for compatibility between insulation and jacket, and for perfectly balanced performance in ducts, conduits, aerial and direct burial installations. ANHYDREX-PLASTEX Cables are recommended for service in a number of environments but especially where oils and chemicals are a problem.

**CATALOGUE #1028**

**ANHYDREX Insulated Control Cables** — Simplex ANHYDREX Control, Signal and Communication Cables have an additional thickness of appropriately coded neoprene over each individual conductor, plus heavy-duty neoprene jackets. ANHYDREX insulation provides excellent signal reproduction and is exceptionally stable, even when operating with high ambient temperatures.

**CATALOGUE #1028**

**ANHYDREX XX** — Simplex ANHYDREX XX is a butyl-based insulation of the highest possible quality. Because of its exceptional resistance to heat and ozone, it has general applications in circuits operating up to 35,000 volts, with permissible conductor temperatures of 90 C. to 5KV, and 85 C to 17KV — in wet or dry locations.

**CATALOGUE #1023**

**CONDEX** — Simplex CONDEX Cables are protected against mechanical damage by interlocked metallic armor. The armor is manufactured of galvanized steel, plain or baked enameled (colored) aluminum, bronze or other metals, and can be applied over any cable core within a very wide diameter range. CONDEX Cables may be further protected by a thermoplastic covering over or under the metallic armor.

**CATALOGUE #1024**

**TIREX SO and SJO Cords** — TIREX SO and SJO Cords are constructed to meet the most rigid specifications. All of their special features are carefully selected and processed to give maximum qualifications for portable service. They will twist without kinking, and bend without breaking. TIREX stranding affords maximum flexibility without sacrificing strength.

Conductor temperature rating 75c

**CATALOGUE #992**

**TIREX Low Voltage Portable Cables** — TIREX Low Voltage Cables are individually designed for specific applications. They are practically indestructible when used to do the work for which they are intended.

Conductor temperature rating 75c

**CATALOGUES #992 & #1011**

**TIREX High Voltage Portable Cables** — TIREX High Voltage Portable Cables have unequaled strength and versatility. Designed primarily to transmit energy to mobile electrical equipment, they are also used as temporary power lines during alterations or emergency repairs.

Conductor temperature rating 75c

**CATALOGUE #1012**

**TIREX Mine Locomotive Cables** — TIREX Mine Locomotive Cables — both single and two-conductor concentric — are approved by the Bureau of Mines and have the raised marking "P-101 BM" on their heavy-duty neoprene jackets. All TIREX Cables are cured and conditioned for service in lead.

Conductor temperature rating 75c

**CATALOGUE #1011**

**TIREX Mining Machine and Shuttle Car Cables** — TIREX Mining Machine and Shuttle Car Cables are designed for stability under today's rigorous mining conditions. The insulated conductors are "ribbed" or gear-shaped. This feature causes them to interlock with the heavy duty neoprene jacket and prevents them from slipping. Both Type W and Type G have "P-101 BM" molded onto the jacket.

Conductor temperature rating 75c

**CATALOGUE #1011**

**TIREX Dredge and Shovel Cables** — TIREX Dredge and Shovel Cables are masterpieces of engineering achievement. Every consideration has been given to safety and durability. Simplex special cured-in-lead neoprene armor effectively resists all the elements normally encountered in this type of work.

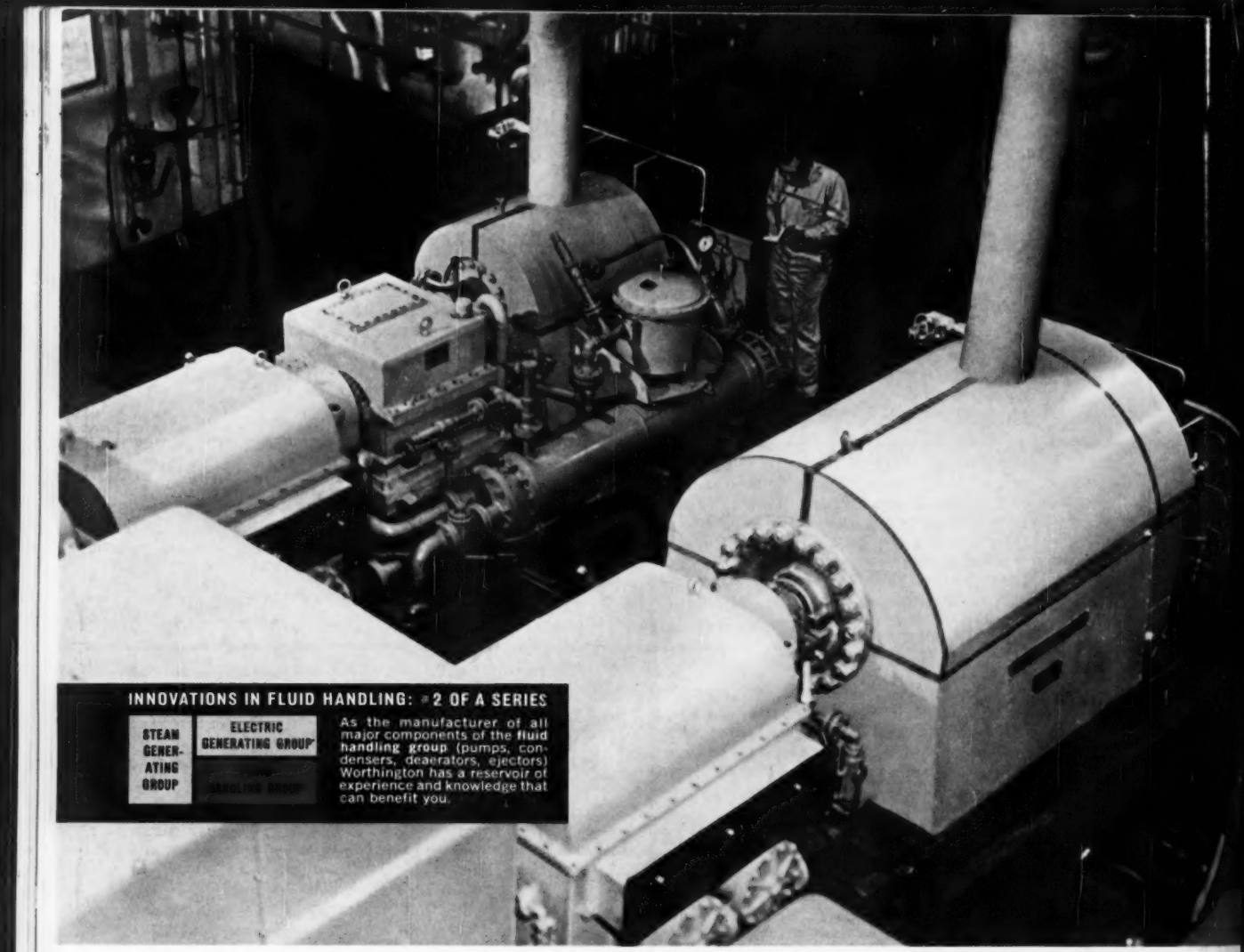
Conductor temperature rating 75c

**CATALOGUE #1012**

**TIREX Welding Cables** —TIREX Welding Cables are scientifically stranded for maximum flexibility without wrist drag. Cured-in-lead neoprene jackets provide utmost safety for both operator and bystanders.

Conductor temperature rating 75c

**CATALOGUE #1011**


INNOVATIONS IN FLUID HANDLING: #2 OF A SERIES
STEAM GENERATING GROUP
ELECTRIC GENERATING GROUP
As the manufacturer of all major components of the fluid handling group (pumps, condensers, deaerators, ejectors) Worthington has a reservoir of experience and knowledge that can benefit you.

**This photo measures pump progress.** Here are two boiler feed pumps with duplicate pressure and capacity ratings. On the right is a unit of conventional speed; the other is the fastest pump of its type in service, running at 9,000 rpm. Smaller size is dramatically evident.

# PUMP PARADOX

## High speed boiler feed pumps are several times as fast, yet actually more reliable

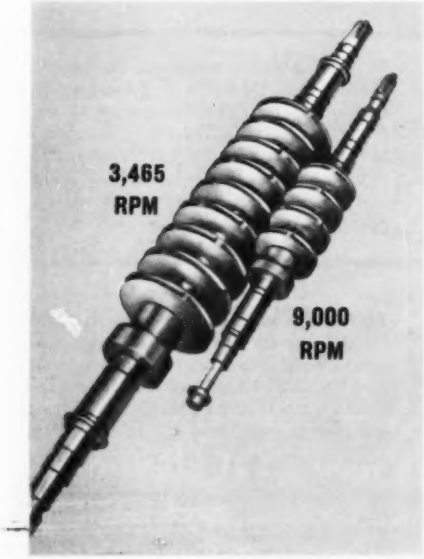
In modern power plants, the demand for higher efficiency has led to higher operating pressures and, therefore, higher heads for boiler feed pumps. This is a critical area for the fluid handling group. Can you obtain these higher heads without sacrificing reliability?

Worthington has proved that you can. By going to speeds twice as fast (and even greater) Worthington drastically reduces shaft spans required. This cuts shaft deflection to a fraction of its former value. Since pump wear, and hence pump life, is directly related to shaft deflection, the high speed pump is actually more reliable than a conventional unit of the same capacity.

Experience in the field has proved the wisdom of Worthington's design philosophy. More than 39 Worthington high speed pumps are now installed and 21 are on order. Speeds range from 6,500 to 9,000 rpm. If necessary, Worthington sees no reason why speeds shouldn't go even higher, without departing from experience-proved construction principles.

Reducing shaft deflection through shorter shaft span is only one way that Worthington increases boiler feed pump reliability. Other ways include larger shaft diameters, liberal clearances, shrunk on impellers, metal-to-metal pressure joints, a special method for measuring internal wear, and anti-oil-whip bearings.

High speed boiler feed pumps are one example of Worthington's leadership in the fluid handling area. Through the years Worthington has made many contributions to the solution of power plant problems. Why not put this progressive "know how" to work on your next plant? Worthington Corp., Harrison, N. J. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.




**Comparison of rotors.** The rotors used in the two pumps above are shown here. The 4-stage rotor used in the high speed pump will have one-third the deflection of the 9-stage rotor in the conventional unit.

WORTHINGTON

CATALOGUE #1011